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PROCEEDINGS

OF

THE MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK

AND

CONSTITUTION, BY-LAWS, LIST OF MEMBERS AND ANNUAL REPORT

1903

NEW YORK
Published by the Society
1904

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THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK

PROCEEDINGS.

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THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.

Paper No. 1.

PARK ENGINEERING IN THE BOROUGHS OF MANHATTAN AND THE BRONX.

By Nelson P. Lewis, Member of the Society.

Presented April 22d, 1903.

The provision of parks and playgrounds for the dwellers in cities is by no means the result of modern civilization, or an evidence of that altruistic spirit which is to-day so active in providing pleasure and recreation for those whose lives would otherwise be hard and monotonous.

In looking for the first attempts at park making, we must go back to ancient Egypt, the land of mystery and the grandmother of civilization. The Egyptians undoubtedly had parks at a time antedating the oldest records on their monuments. They are supposed to have had formal gardens in which architectural features were freely introduced. The idea of parks was borrowed from Eygpt by the Assyrians, and later by the Greeks, who were indebted to the country of the Nile for so many of their arts and sciences. The Romans, in turn, carried park development much further than did their predecessors, and Rome, in the days of the Cæsars, became one great pleasure-ground. Their parks were not only many, but large, and afforded generous facilities for games and amusements. The Romans were always lavish in their use of water, and they introduced it freely in their parks, as lakes, cascades, and fountains. Besides the public pleasure grounds, the emperors and wealthy nobles had their private parks, many of them of great extent, and treated with much elaboration.

Park building suffered the same relapse as did learning and the arts during the long, dreary middle ages, but with their renaissance came its own revival, and Louis XIV gave Paris a great system of parks and gardens. The French capital has, in this respect, retained its pre-eminence among the great cities of the world, as will be seen by a comparison of the park reservations of some of them drawn to the same scale.

For many years only a few of the world's great capitals possessed public parks, and they were due to the alleged munificence of rulers who could levy such taxes as they saw fit, to reimburse themselves for the outlay. It was well along in the 19th century before the park idea became so well established in the minds of all city dwellers that every community capable of supporting a city government voluntarily taxed itself to provide something in the way of a public park.

According to the third annual report of the Board of Park Commissioners, made at the close of the year 1873, a department of Public Parks in the former City of New York, or the Boroughs of Manhattan and the Bronx, had its beginning as recently as 1870. There had been since 1857 a Board of Commissioners of the Central Park, and, at the time of the report referred to, there were fourteen parks over an acre in extent, and sixteen small public places ranging in size from less than one-third of a city lot to an acre, and having a combined area of 1 094 acres, of which 859 acres were in the Central Park, and 89 in Riverside Park. This report contains considerable statistical information about the Central Park, some of which may be of interest.

In 1849, Mr. A. J. Downing publicly urged the need of a large park for the City.

In 1851, Mayor Kingsland recommended that the Common Council consider the question, and a committee of that body reported favorably.

In 1853 the Legislature passed an act fixing the present site of Central Park below One Hundred and Sixth Street.

In 1855, a resolution was passed by the Common Council favoring a reduction of the area, but it was vetoed by Mayor Fernando Wood.

In 1856, Egbert L. Viele was appointed Chief Engineer, and a topographical survey was ordered.

In September, 1857, competitive designs for laying out the park were invited. The designs were received in April, 1858, and publicly exhibited for thirty days.

Work was ordered begun under the adopted plan on May 4th, 1858, 2 000 men were at work in August, and the first tree was planted on October 17th. During November there were 2 600 men at work. Water was let into the lake on December 7th, 1858, and the first skating was 12 days later, on December 19th.

The year 1859 was an active one, the average force of laborers employed during the year being 2 977, and in December the Commissioners announced the construction of the Park south of Seventy-ninth Street to be completed, and plans were ordered prepared for an extension to One Hundred and Tenth Street. This is certainly a remarkable record of vigorous prosecution of public work, and yet, in June of the following year, a Senate Committee came down from Albany and investigated the management of the park.

During the year 1864, it is noted that two regiments of the National Guard illegally paraded in the Park, that English sparrows were introduced (seven pairs) and the number of visitors to the Park during the year was 6 120 179.

In 1869, the self-registering apparatus was first used at the meteorological observatory, a museum of natural history was established in the Arsenal, and steam rollers were first used in the Park roads.

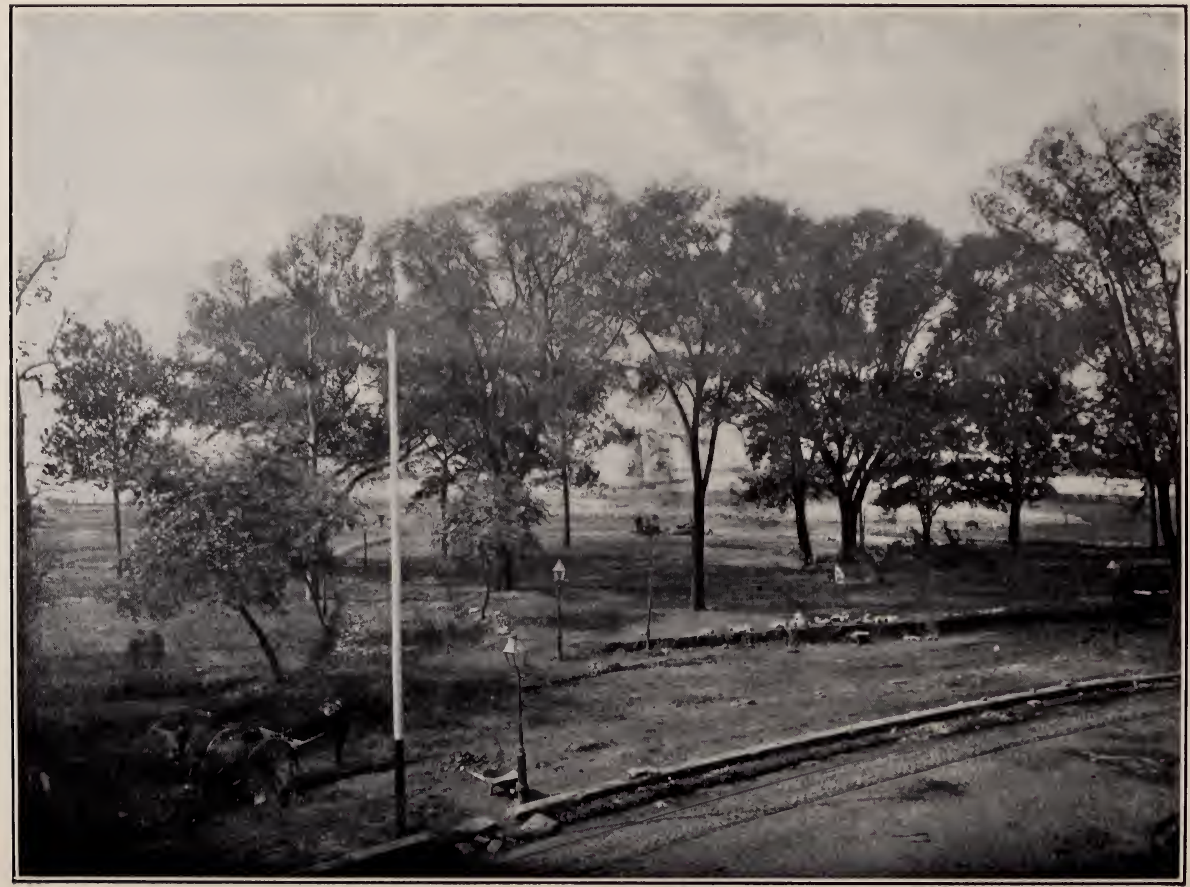
The investment of the City, in Central Park, up to the end of 1873, was, in round numbers, $13 902 500, of which $5 029 000 was for land, and $8 873 500 for its improvement. The President of the Board, at that time, the late Mr. Salem H. Wales, calls attention to the assessed valuations of the real estate in the three wards adjoining the Park at the time of the report. The average increase in values in other parts of the City from 1856 to 1873, had been about 100% at which rate the valuation of these three wards would have been about $53 000 000, whereas it actually was $236 000 000, so that the increase, instead of 100%, as in other parts of the City, was nearly 800%, and this enormous increase, he thinks, was undoubtedly the immediate result of the expenditures made upon the Central Park. These figures certainly demonstrate that judiciously planned parks are not only a luxury, but a wise investment. The remarkable progress made, in building the park below Seventy-ninth Street in about eighteen months, is the more worthy of note when it is remembered that most of the artificial features of the Park are located in this southerly end.

Between Eighty-sixth and Ninety-sixth Streets is a large reservoir occupying nearly the full width of the Park, and under the control of the Department of Water Supply. This reservoir was shown in the first studies which were made for development, and while those in charge of the Park feel that it does not belong there, and is a serious encroachment upon the area designed primarily for the use of the public, the narrow strips on each side have been most skillfully treated to give an impression of distance, and it is probable that those of you who are fairly familiar with the locality are astonished, upon looking at a map of the Park, to see how large a part of it is occupied by this reservoir, and your surprise is an unconscious tribute to the genius of the landscape architect or park engineer who so designed it. The little tower at one corner of the reservoir is an attractive decorative feature.

It is pertinent at this point to remark that reservoirs can be made a most important adjunct to the park system of almost any city, as has been done at Brookline in the Boston system and many other places, while at Detroit and Chicago even the pumping stations are made the centres of charming bits of river-side and lake-front parks which present a marked contrast to the unrelieved ugliness of our own Ridgewood reservoir and pumping station.

But, having plunged at once into Central Park, the most pretentious and the best known of all the city's parks, let us begin again at the lower end of Manhattan Island, and in a more leisurely manner, travel northward and note some of the most characteristic features of the people's playgrounds. First let me confess that this is not to be a dissertation upon park engineering so much as a few superficial observations by an engineer upon the development and present state of the parks of Manhattan and the Bronx.

The Battery, in the early part of the last century, was quite limited in extent, and Castle Garden was then an island, the most pretentious place of amusement in the city, and one where quite elaborate entertainment was offered. It was here that Jenny Lind sang her way into the hearts of New Yorkers. But the present Battery Park is of much more recent date, and in 1870 was in the throes of construction. It was then that the sea wall was built and a large



The Battery in 1870—from a photograph by Rockwood,

part of the park as we know it to-day, was appropriated from the domain of Neptune. It was not long after the completion of the park that the elevated railroad was permitted to place its structure along its inner edge. Much has been said of this as a piece of vandalism, and hysterical demands have been made for its removal, but the speaker must confess to being unable to discover where it could be placed to give less offense, and still continue to do the work for which it was designed.

But, at the time when the Battery was given over largely to warlike purposes, the people had a playground a little farther up Broadway in the Bowling Green. The old iron fence which still surrounds it is a relic of Colonial days, and the posts which now have an apparently crude and irregular top, were once adorned by the effigies of the same George whose statue stood in the park, but they were broken off at the same time that George himself was sent back to his loyal subjects in the shape of bullets.

A little to the east is what will soon be another interesting small park, one-half of the block bounded by Broad, Pearl and Water Streets, and Coenties Slip, having already been laid out as a public park, one corner of which will be occupied by Fraunces' Tavern, the preservation of which historic building will be thus insured.

One walking up the Broadway in 1822, would have found near what was then the upper limit of the city, a charming little park surrounded by an iron fence and filled with shrubbery, in the center of which was located what is still pronounced to be the most conspicuously successful piece of architecture among all of our public buildings. It is a source of endless regret that any encroachments upon this space were ever permitted, and it has even been urged that millions of dollars should be expended in restoring City Hall Park to its former condition, and that even the Post Office and Court House should share the fate of the old Hall of Records, as the fire-engine house and the City Court building are soon to do.

A little farther uptown on the East Side, we would, but a few years ago, have found ourselves in a network of narrow streets, where vice and crime never slept, for we were in Mulberry Bend. Then came Jacob Riis, with his long uphill fight against the slum and his plea for letting in the light, which resulted in the Mulberry Bend

Park as it is to-day. Call this park engineering, or humanitarian engineering, as you will. It may not be work which calls for a high degree of technical skill, but the great bridges, the extensive parks and grand boulevards which are being built reflect no more—no, not so much—credit upon the city as do these small parks. But you will note the formal treatment of this park and of another on the west side at Hudson and Leroy Streets, where what was formerly St. John's Cemetery has been converted into an exquisite little pleasure ground, the architectural features of which were designed by Carrere & Hastings.

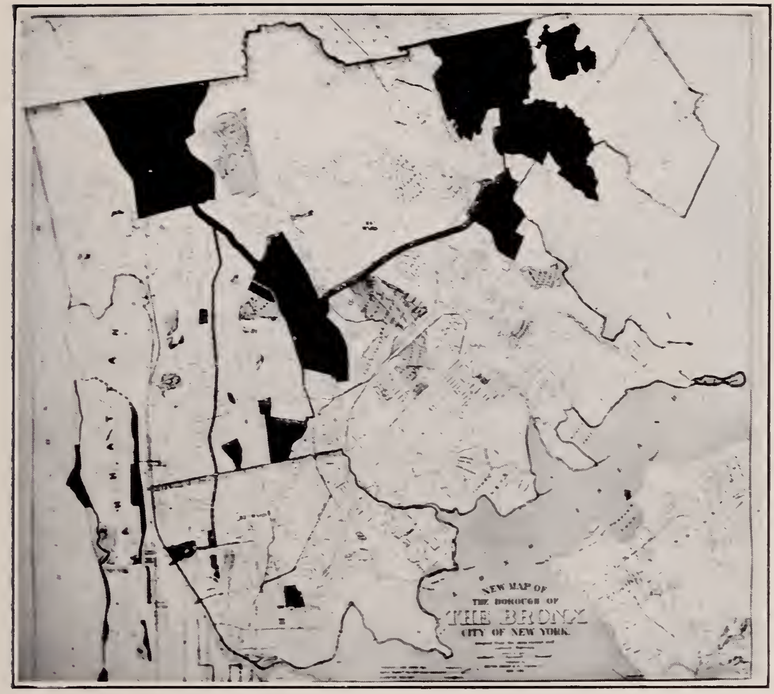
The more recent practice, however, in the development of small parks, in the densely populated portions of Manhattan, has been radically different. Formal and decorative features have been subordinated to amusement, particularly the kinds of amusement which appeal to children, running tracks, an out-door gymnasium, gardens where the little people can plant and care for their own flowers, as in Seward Park, at East Broadway and Norfolk Street.

Going back to the west side, between Fifty-second and Fifty-fourth Streets, Eleventh and Twelfth Avenues, we find what is designed to be DeWitt Clinton Park, although it has thus far reached only the stage of demolition of the old buildings. The plan for its development is typical of the modern treatment of small parks, which are primarily playgrounds, though in this case it will be seen that a certain amount of formal treatment is contemplated at the westerly end, which is immediately adjacent to the North River.

On our way uptown we must not forget to note the importance of breaking the monotony of our important business thoroughfares by open spaces and patches of verdure, as is done along Broadway at Union Square, the northerly end of which was designed as a muster ground, a place for large mass meetings, where it was estimated that 20 000 people could stand without interfering with the City's traffic, as in Trafalgar Square in London, but the New York populace do not seem to fancy open-air meetings.

The next open space along Broadway is at Madison Square, which is admirably located in the center of the shopping district.

Abandoning Broadway for the Fifth Avenue, we come to Bryant Park, where the familiar vine-clad walls of the old reservoir have disappeared, a part of them having been made over into granite paving



The Park System of Upper Manhattan and the Bronx.

Hudson Park, at Hudson and Leroy Streets, formerly St. John's Cemetery.

blocks, while a large portion of them has been used for the foundations of the new public library, a model of one panel of which has been erected on the site. New York has learned to be jealous of any encroachments upon her park spaces, but the substitution of this beautiful building for the old reservoir seems to meet with popular approval.

We will stop for a moment to look at the extension of East River Park at Eighty-sixth Street, where a commanding site overlooking Hell Gate has been preserved to the public as one of our most attractive water-side parks, and will then note two stages in the development of Jefferson Park, between One Hundred and Eleventh and One Hundred and Fourteenth Streets, First Avenue and the East River. First there are the foundations of what were lately squalid tenements, soon followed by a playground, for we in a neighborhood housing an immense population, largely Italian. We have passed on our way one of the most beautiful of the many islands which form a part of New York, and it is a cause for regret that Blackwell's Island should be given over to penal institutions. Riker's Island, further up the East River, is being enlarged, so that over 220 acres will be added to its area, and it is probable that in the not distant future, these institutions will be transferred thither, where there will be ample room for them, and one of the most attractive spots in all the City will be added to its park spaces.

You have doubtless noticed that thus far we have gone from one park to another, sometimes for a few blocks, and again for considerable distances. Each of these parks is independent of the others, and in no way connected with or related to them. This is certainly a logical treatment for the greater part of Manhattan. The lower part of the Island is so completely built up, and the land is so exceedingly valuable, that a chain of connected parks is out of the question. From now on, however, the park plan is entirely different, and we have what is, strictly speaking, a park system, or a series of open spaces connected by boulevards and parkways of liberal dimensions, so that one can have quite a whole day's drive without leaving the jurisdiction of the Park Department.

There are, it is true, some small isolated parks, but they are exceptions. Many of these large reservations are what are often called undeveloped, but their naturalness is their great charm, and it is doubtful if there can anywhere be found a group of parks having such superb natural advantages as these. The area which has been reserved may seem extravagant, but the land was purchased before it became expensive, and the City has undoubtedly made an admirable investment.

In this connection, I cannot but go beyond the bounds prescribed by my title, and show you a scheme of parks which has just been proposed for the Borough of Richmond. This will doubtless be called extravagant, but with some trimming it may form the basis of a wise movement to secure a liberal system of reservations which will ultimately prove of enormous value to the City. There is a growing tendency to provide places for public amusement, especially for health-giving, out-of-door sports, and where could public golf links, tennis courts, baseball, football, or cricket fields be more delightfully located than in this picturesque island borough of Richmond?

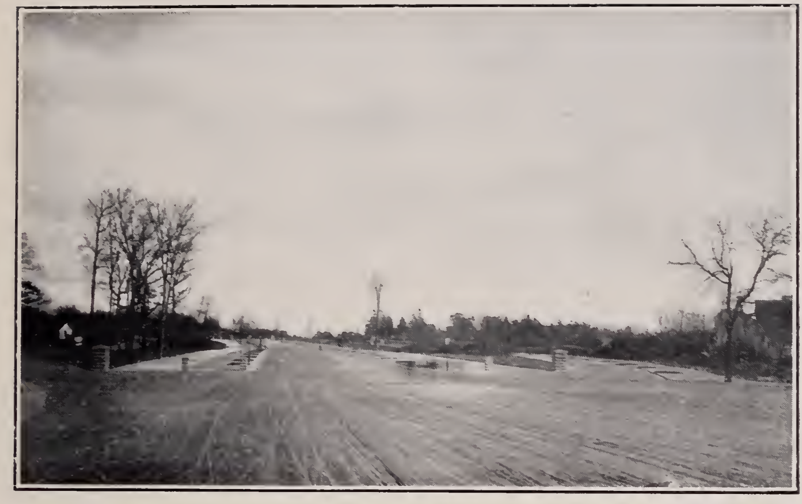
The parks of upper Manhattan and of the Bronx, as already noted, are connected by a system of boulevards, some of which have been treated elaborately, while others have all the simplicity of a country road. The Riverside Drive and adjacent Park show specimens of this formal treatment, the planting in the parkway being shrubbery and dwarf varieties of trees, so that the superb view of the river is not cut off from the houses on the easterly side, nor from those passing along the drive. This thoroughfare is carried over some of the intersecting streets by viaducts, as at Ninety-sixth Street, where a steel arch bridge is used, with connections between the footways of the two streets. Near this bridge has also been placed a public comfort station. Crossing Manhattan valley by a long and high viaduct, the Drive is to be extended northward to the Boulevard Lafayette. A contract is about to be made for this extension, and both the road and park lying between it and the river will be treated with great elaboration, making it by far the most pretentious boulevard in the possession of the City. The Boulevard Lafayette, on the other hand, is entirely devoid of ornamentation, but is one of the most charming bits of roadway to be found in this or any other city. This road now ends at Dykman Street, but it will doubtless be carried over the valley to Inwood, skirting this bold promontory, crossing the Ship Canal to Spuyten Duyvil, and proceed along the Hudson to the City line or even beyond, to form a part of a grand State or National Highway, if that dream of the good road enthusiasts is ever realized.

Coming back to Dykman Street, we can cut across to the Speedway, built for the use of owners of fast horses, but which furnishes entertainment for thousands who can never expect to own a horse, but who throng the sidewalks every fine day.

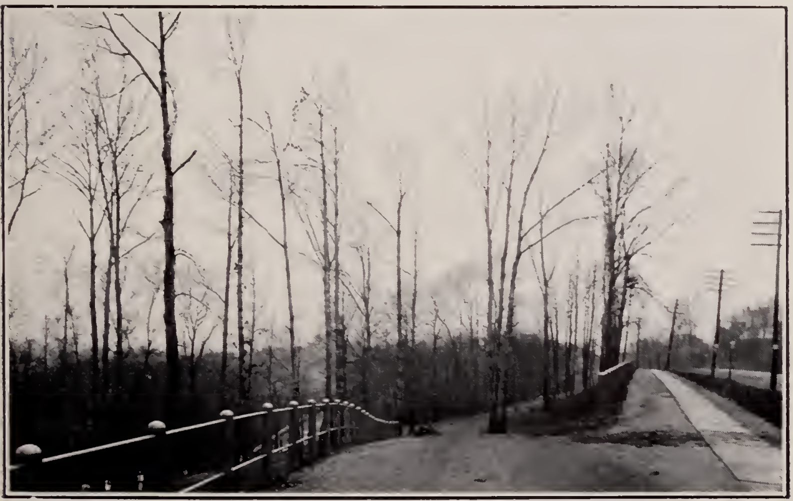
Passing along the steep slopes of High Bridge Park, under Washington Bridge and High Bridge, we are impressed with the fact that monumental structures of this kind enhance rather than detract from the beauty of our parks. Turning back for one more look at the Speedway and the bordering park, from beneath the noble arch of the Washington Bridge, we pass under the beautiful High Bridge, and climb the hill leading to the One Hundred and Fifty-fifth Street viaduct, from which we look back and note the skillful way in which distance has been increased to overcome the grade of St. Nicholas Place, and obtain one more glimpse of High Bridge, while before us is another of the historic buildings of the city, the Jumel Mansion, which it is also proposed to take, as a public park, in order to preserve an additional memorial of Washington and his heroic but unsuccessful struggle to hold these heights against the advances of the British army.

Crossing the viaduct we come to the site of McComb's Dam and Bridge, which must have been a charming spot when the old road led across it, connecting the country below the Harlem with the country above. A modern bridge has taken the place of the old structure, and while it was for a time known as Central Bridge, the old name has fortunately been restored. As we pass from the parks of Manhattan to those of the Bronx, we have another illustration of what can be done even with a bridge of this kind. Its surroundings were unattractive enough when the bridge builders completed their work, but the space on both sides has been made a public park, and the little grading and planting which have been done give promise of a still further transformation which a few years will show. Another viaduct along One Hundred and Sixty-first Street, which is soon to be built, will, with McComb's Dam Bridge, connect the Borough of Manhattan with the beginning of the Grand Boulevard and Concourse, a contract for the preliminary grading of which has recently been let at a cost of more than a million of dollars. This is to be a magnificent thoroughfare, 182 ft. in width, following the crest of the ridge to Mosholu Parkway, which is itself a park 600 ft. wide, connecting Bronx Park with Van Cortlandt Park. The Bronx and Pelham Parkway, 400 ft. in width, similarly connects Bronx and Pelham Bay Parks, so that from the northwesterly corner of Van Cortlandt Park at the Yonkers line, and but a short distance from the Hudson, one will be able to ride through a continuous park, beside beautiful lakes, through magnificent forest, crossing picturesque streams, along the rocky shores of Long Island Sound, to the northeasterly corner of the city. Even now there is but one break in the continuity of park. The Bronx and Pelham Parkway has not yet been improved, but the work is under way, and it will not be long before a fine road will be ready for use, though the effects of the planting can only be produced in time. This road will take you over the tracks of the Harlem River branch of the New Haven Railroad, now being bridged, and through a superb growth of forest trees, across Eastchester Creek by a bridge, which is not a creditable structure and which the park engineer of the Bronx has found it difficult to keep in condition to accommodate the travel. Plans for a new bridge have been prepared, and the money has been provided for its construction. You can now lose yourself in the depths of Pelham Bay Park, the largest and in many respects the most advantageously located of all the city's playgrounds but it is, unfortunately, the most inaccessible at the present time.

The difficulty of getting to and into this great reservation of 1 750 acres suggests one of the most serious questions confronting those in whose custody the parks are placed—namely, to what extent, if at all, shall transportation lines be allowed to enter or encroach upon the park lands. The principal object of a large park such as this is to enable those who cannot afford to leave the city during the summer months to obtain a taste of the real country. As said by Olmstead Brothers, the landscape architects to the Metropolitan Park Commission of Boston, in their report for 1900: "It is not merely that they can sit on the grass and see about them only the foliage of bushes and trees and the blue sky overhead—that could be provided for in a good sized back-yard by a skillful designer—but also it is that they can move about freely without feeling that at any moment they may step out into the streets. It is real, honest country, near enough to the heart of the town to be reached by people who have not the money and time for railroad journeys into the bigger country off beyond."



THE BEGINNING OF THE BRONX AND PELHAM PARKWAY.



THE UNPRETENTIOUS ENTRANCE TO UNIVERSITY PARK.

A steam railroad now passes through a part of Pelham Bay Park, and there is a little single track horse railroad running from Bartow Station to City Island. If it were proposed to build a modern electric railroad into this park or even around the edges of it, there would be a howl of protest, and yet there seems no other way to render it accessible to those who have neither automobile, horse nor bicycle. If such a railroad were permitted, it should be kept as much out of sight as possible, and under no circumstances should it be allowed to cross at grade any of the roads in or leading to the park.

Having made a hasty tour of the public parks from the Battery to the "Ultima Thule" of the Bronx, let us now look more closely at some of the details of park building. Assuming that a judicious selection has been made of the ground to be set aside for the free use of the public, the landscape architect or the park engineer must undertake the work of development. This requires the most careful preliminary study before a tree is cut or a bit of earth is disturbed. Nature has done her work, and we must be careful not to mar it. The most attractive natural features should be accentuated, but except in the case of a few formal drives and gardens, a fountain or architectural adjunct, man's work must be kept in the background.

The first step in development is the laying out of roads. These must not be too wide, or they will make the bordering wood or meadow appear contracted, and an effect of distance is to be given to all natural features. Where our road is to go through a wooded portion of the park, do not sacrifice an unnecessary tree, but avoid the effect of dodging them, for our curves must be easy and natural, and not sufficiently abrupt to obstruct the view of vehicles coming in the opposite direction. Many of these things will cause deep distress to the engineer who has been schooled in other fields, and special training, coupled with peculiar adaptability, is essential to success in work of this class. This has been so admirably expressed by Mr. G. A. Parker, the Superintendent of Keney Park, Hartford, that I beg leave to quote from a paper read by him before the American Society of Municipal Improvements in Rochester last October. He said:

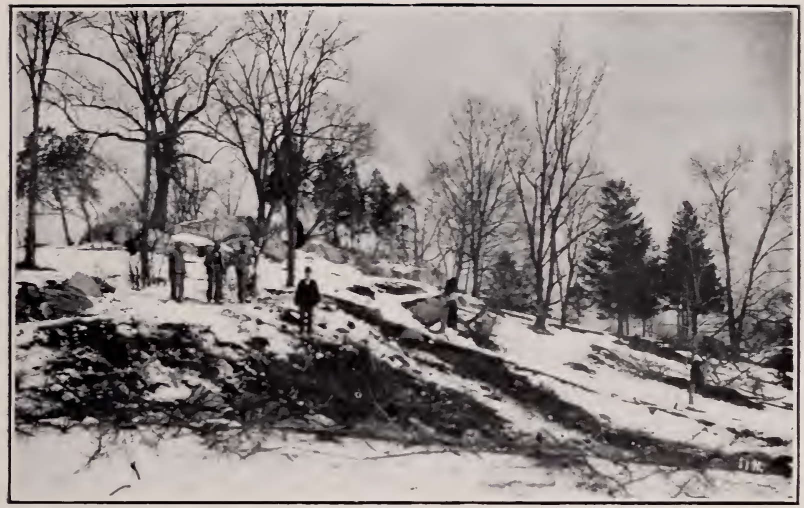
> "As a rule all engineering work requires exactness of detail as to lines and surfaces and the laws of physical forces must not be violated, but in naturalistic parks the engineer's idea of exactness of detail becomes an offense, for it is not the perfection of detail mathe-

matically correct that gives pleasure here. It is the relation, the proportion and correspondence of things that brings satisfaction.

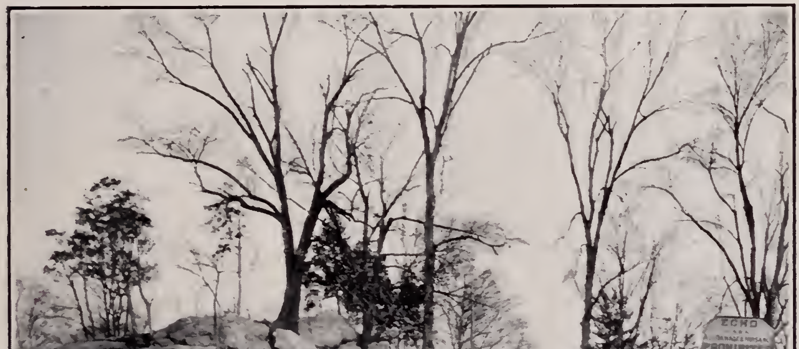
"That a different mental makeup is required in the park engineer from his brothers in the other line of work, is illustrated by the fact that a man with an engineering mind delights in the exactness of lines and angles and the mastery of forces, and so is all at sea when he comes to park work. To the engineer, be the prick point on a plan never so small, it is larger than his conception of a point, while the dob of an ink stopple more fully represents the point to the landscape mind. In the field, when an engineer establishes a point he drives a stake, puts in a tack and makes cross lines on its head, but to the park man a point is a quarter of an acre or more. To the engineer a line has length and direction, but to a park man it may be a range of mountains, or a river, or a row of trees, and the landscape line always has width. The true engineer is disturbed by all this undefiniteness. My experience with them is that they have to so violate what they believe is most sacred that they seldom become reconciled to park work, or else they put the parks into the straight-jacket of their science. Now, I am not belittling engineering skill—parks cannot be made without it,—but it is only the skeleton which sustains the flesh, that is, the moulding of the soil with its rounded surface. The trouble with the engineer seems to be that he wants to put the skeleton on the outside where the turtle has his, but if he does so he produces no higher grade of landscape work than the mud turtle is among animals. I honor and admire the skill of the engineer. I know only too well its fundamental importance in the foundation study of parks, but in parks it must be hidden and never appear on the surface."

Mr. Parker also argues that the skilled gardener is no more successful as a park builder than the man of straight lines, angles and regular curves. He has too deep an affection for the individual flower, shrub or tree, while in successful park work the single plant is considered only in its relation to the whole of which it is but a small part.

Straight lines and radial curves are offensive, not because they are straight and radial, but because they do not fit into the landscape. The predomination of a physical force is also suggested by such lines, for in order to produce a straight line, a projecting force of sufficient intensity to overcome everything in its way is suggested, while a radial curve is controlled from its center—both, therefore, representing a single controlling physical force, and nature never produces by single forces the effects we desire, but they are the resultant of many forces differing greatly from each other.



The Site of Echo Park.



Echo Park, after Improvement.

In determining upon the line and grades of roads and paths, therefore, the greatest care is required to avoid artificial effects, and yet some general rules or laws must be observed. First, certain points must be selected where the road or path is to be, and its direction at these points, and these must then be connected. Various incidents of the landscape between these points will influence the details of its location, such as hills, valleys, rocks, trees, a brook, or a distant view. If such incidents do not occur, in order to break the straight line they must be introduced by planting or grading if need be, but always in such manner as they might have naturally existed.

You will see how slightly the natural conditions have been interfered with in building some of the roads in Bronx Park, and yet there is enough grading in evidence to suggest the setting of slope stakes and the computation of the amount of cut and fill.

The entrance to University Park, however, appears to drop away from Sedgwick Avenue in the most natural manner, and one is irresistibly attracted to this little spot which has been preserved along the banks of the Harlem. The Bronx, with its varied topography, has many exquisite little spots which have been thus availed of. There is the rocky knoll between Tremont and Burnside Avenues, which must have been the despair of real estate speculators, but which by clearing out the brush and making a path or two has been converted into Echo Park. There are other places where there are few if any natural beauties, but where some one has thought a park should be located, and has had influence enough to have it selected for that purpose. Nothing could have been much less attractive than the condition of Cedar Park, although it occupies a commanding site overlooking the Harlem and near the beginning of the Grand Boulevard and Concourse, but its improvement has been started, and the grading of the bank, the laying out of a path, and a little planting give a suggestion of what it will soon become.

Many interesting historical sites have been preserved, some of them extremely simple, as the "Pell Oak" in Pelham Bay Park, under which Lord Pell is said to have made a treaty with the Indians, although I confess to being unable to find out who Lord Pell was, with what Indians he treated, or what he treated about. Another site is that of McGowan's Pass, where British fortifications were once located, and which is about at One Hundred and Sixth Street and Sixth

Avenue in Central Park. This is not recognizable now, but a glance of the old prints representing it will help us to realize the kind and amount of work which was done to convert the lower end of Central Park, in the short space of 18 months, into what it now is.

There is one type of park engineering to which I cannot forbear to refer, namely the engineering of deals to secure the purchase of small parcels of land as public places for the benefit of the owners of the property to be so taken. A good instance of this is the so-called public place at East One Hundred and Thirty-eighth Street and Mott Avenue in the Bronx, where two small triangular spaces, one on either side of the railroad viaduct, were taken, the owners being paid for the same the neat little sum of $40,541.95, while the expenses of the Commission were $8,815.97, making a total cost to the City of $49,357.92. This is the most remunerative kind of engineering of which I know.

But there are many places, especially in Bronx Park, which simply want to be let alone, such as those along the Bronx River, where it is hard to believe that one is not miles away from the din and turmoil of the City. It is up this stream that the British commander in New York during the Revolution is said to have been ordered to take his fleet to capture White Plains. This was once the scene of manufacturing enterprise, but it is now given up wholly to recreation for the tired workers of the metropolis.

There are reminders of the hum of machinery in the ruins of the old mill and dam just below the Bronx and Pelham Parkway, which have been retained as attractive features of the park. Above this is a stretch of smooth water, admirably adapted for rowing and canoeing.

There is a picturesque bit at the lower end of the park, and outside of its limits which the contractors who are building the Rapid Transit Railroad have purchased for a station and storage yard, bringing this reminder of the busy life of the City almost within the park, but steps have already been taken to add this to the area of the park with two additional blocks, in order to form a more imposing entrance to the Zoological Garden, and the contractor is said to have consented to transfer his land to the City for a consideration representing its cost to him.

Now, a few words about structures which can properly be placed in our parks. The artificial must be strictly subordinated to the natural, and great care must be exercised in admitting what are claimed to be works of art. Our park authorities are constantly being importuned to consent to the placing of statues or fountains in commemoration of some event or of some individual within the park grounds. The bridges necessary for the park roads and paths offer excellent opportunities for decorative effects, and they have been skillfully availed of in both Central and Prospect Parks, as a few illustrations will show. Fountains can be used effectively, but the authorities were doubtless wise in excluding so pretentions and elaborate a creation as the Heine fountain from the parks.

There was a large fountain formerly on the plaza in front of Prospect Park, and it was ridiculed by many of the Brooklyn people until it was removed, and for it was substituted a hideous construction which when first built was used for an hour on two evenings of the week as an illuminated electric fountain. It has been out of commission, however, for several years, and is such an offense to the eye, both by day and by night, that the people of Brooklyn, if I mistake not, would again welcome the old umbrella, as it was disdainfully called.

Finding myself outside the limits imposed by my title I will close, with the hope that the lack of engineering features in what has been presented will be overlooked if something has been added to your knowledge and appreciation of what has been and is being done by the City for the comfort and pleasure of her citizens.

DISCUSSION.

Mr. D. Ulrich —There is a parkway called the Spuyten Duyvil Parkway, that commences at the New York Central station at Spuyten Duyvil and has been constructed over to Van Cortlandt Park, a distance of 2½ miles. It contains about 80 acres, is anywhere from 200 to 40 ft. wide, and is a direct connection almost. All we have to do is to build a bridge across the Spuyten Duyvil and make a connection with the Boulevard Lafayette, so that it is a direct connection through the Bronx Borough of the whole park system, and by going through Van Cortlandt Park and through the Bronx Park into the Bronx and Pelham Parkways, and through Pelham Parkway, there will be a distance then of about 11 miles of park drive direct. Of course, there will be more of a distance if any detours are made in the parks themselves.

Mr. Wm. F. Johnes.—With regard to the statement made that there is no direct connection except by going some distance to the north and then coming back, I would like to say that Pelham Avenue, which is an extension of the Pelham Parkway, is a road about 100 ft. wide, and that it crosses the Concourse just north of One Hundred and Eighty-ninth Street and runs through Bronx Park just at the edge of the Zoological Gardens.

Mr. D. Ulrich.—There is also another connection that should be made from the Bronx Park through the Crotona Parkway into Crotona Park, and then across Wendover Park to Claremont Park, and then from Claremont Park right into the Concourse. That is another park drive that was considered and is almost laid out. I think it is building now.

Mr. N. Hill, Jr.—I would like to make a suggestion in regard to park improvements. The plans for the extension of the Riverside Drive were submitted to me some weeks ago for the purpose of laying out the water mains along the drive. The engineers in charge of this improvement realized the fact that all the intersecting streets had to be served with water, and it would be beneficial that there would be no dead ends on these streets in which the water could become stagnated. I found, in reviewing the plans, that in every one of those bridges the arches were so close to the surface that there was no possible way of laying water mains across the bridges. I simply offer this as a suggestion on the subject, because I think that in laying out parkways for this purpose the practical thing might be considered as a fact.

Mr. E. A. Miller.—Mr. Lewis in his paper practically covered the question of parks. A remark was made that the engineer in general is too fond of straight lines and angles, and consequently is not a park man. This is true. In park work we very seldom recognize straight lines and angles, especially in landscape work. I am sorry to say that I was not present during the early part of the reading of Mr. Lewis' paper, and I do not know how much he entered into the subject of construction and general treatment of parks.

A moment ago Mr. Hill stated, "That the scheme of water supply on the parkway known as the Riverside Drive Extension had been submitted to him for the purpose of laying a water system, and that he found that the arches are close to the surface, consequently a water system could not be introduced."

I beg to state that the Park Department had no jurisdiction in the matter of constructing this parkway,—in fact, no authority.

As to the general treatment of the park work, I might state that it should be the object of the engineer to conform his work as nearly as possible to the general original topography of the land or the territory to be improved.

Many years ago, when the park system, or rather more properly speaking, Central Park, was suggested, a meeting was held here in New York and opinions were freely given on the subject, and if reports can be taken as facts, statements were made that a park in this city would not be patronized by the better classes of people; that nobody would care to go there; that it was a waste of public money. Nevertheless, Central Park was constructed, and a great deal of money was spent on the same, and the falsity of the statements of prominent people in the fifties as to its not being patronized is fully proven.

What the laying out of park systems has done for the City of New York as to affording breathing spots, as they might be termed, is not necessary for me to mention. In addition they have increased the values of real estate. One feature as to park work—(which at this time I am led to believe cannot be introduced in Manhattan, still it might be considered in the Bronx and Brooklyn Boroughs, as well as in Queens and Richmond)—is the construction of connecting links or parkways between the different parks. As to Manhattan, I might state that about two years ago the question of condemning parcels of land in order to make a continuous parkway from Cathedral Parkway along Morningside Park, thence easterly up St. Nicholas Avenue, and so on to the Harlem River Driveway, received considerable attention; but the cost of the lands, without taking into consideration the construction of the parkway, was so enormous that the matter was practically dropped.

The treatment of these parkways might also be considered. For example, we call One Hundred and Tenth Street (between Seventh Avenue and Riverside Drive) Cathedral Parkway. The roadway is asphalted and the steeper grades are paved with granite block. Trees are planted on each side, and it requires considerable imagination for an outsider or non-resident to accept the street as a parkway.

I might go further into these details as to other streets known as parkways, but I simply mention this case to show that money might be very profitably spent in improving these streets.

There is just one more point that might be touched on, and that is, that in acquiring title to lands which are to be condemned to park purposes, some consideration should be taken as to the general topography, and that lands fronting on the water are desirable. Parcels of land upon which the rock shows prominently can be treated in an artistic manner, but the cost is great when compared with the flat areas.

I thank you for your kind attention.

Mr. M. Schenck.—With us up in the Bronx and our parkway, the engineer, as a landscape architect, has very little to do. Nature has already done the work and the only thing we can do, or should do, is to abstain as much as possible from any destruction of nature. We are doing quite a little up there. Many of our larger parks are of a character that require, as I said before, the management of the landscape architect or the engineer. On the other hand, we have unloaded upon us a whole lot of lands which I think could have been put to other purposes and for this reason we have had to fill swamps and dike lands and everything of that description. Now, in regard to the connection between Manhattan and The Bronx, there is one link, one particular link, and that is the only one along the west side. I hope we will live long enough to see The City of New York acquire every bit of the river front from the end of the Riverside Drive up to the City of Yonkers. With a bridge now being built a connecting link should be made with the roads which will be built in Manhattan. We have also one particular line of connection between the parks that I think has not been touched on to-night and that is the entrance from the end of Mosholu Parkway across the Botanical Garden, a large, wide road, proposed portions of which are being built now which will pass through the Botanical Garden and will reach the Pelham Parkway at or near the principal entrance of the Zoological Garden, and that will be the complete connecting link with all those parks in the northerly end of The Bronx. Then we are at present building the Crotona Parkway, which connects Crotona Park with Bronx Park, and from that point there is nothing at present to connect over to the Grand Boulevard, the Concourse, but we hope to see something done in that direction and also we hope to see a connection on the east side made with Manhattan across some one of the bridges, either the First

Avenue or the Willis Avenue Bridge. I cannot think of anything more that would interest you at present, and as the ground has been very fully covered I think I will stop here.

Mr. L. S. Tribus.—May I ask for statistics as to the park area in Manhattan and The Bronx?

Mr. H. W. Vogel.—I think I can tell the gentleman about the area of the parks. Greater New York has, in round numbers, about 7 000 acres of parks, probably something less, of which Manhattan and Richmond, being under the control of one Commissioner, have about 1 500 acres, Brooklyn and Queens about 1 500 acres, and The Bronx 4 000 acres, so that The Bronx has 1 000 acres more than all the other Boroughs put together. The acreage of The Bronx is about 26 000, so that about 15% of the area of The Bronx is in Parks. Mr. Lewis spoke of how Central Park increased the value of property in its immediate neighborhood. We have a more recent evidence of the increased values caused by parks. I have stated how large a percentage of area is occupied by parks in The Bronx and the result was seen the moment that the Tax Department put the full valuation on the property in the City of New York. In The Bronx the increase was 60%, in Brooklyn 20% of the former valuations, so I am glad to see that Richmond is going to get a large increased area of parks. The increase in valuation will soon be evident. I am glad to see that large parks are proposed for Queens and for Brooklyn.

THE MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK.

Paper No. 2.

THE OLD ROMAN AQUEDUCTS.

By Edward Wegmann, Member of the Society.
Presented May 27th, 1903.

For the first 441 years after the foundation of Rome, the citizens obtained their water supply from the river Tiber, flowing through the city, or from springs. Within the walls of Rome were twenty-three famous springs that have been described in history.

About 312 B. C. the Romans built their first aqueduct, which was known as the Aqua Appia (Appian Water). It was constructed by the censor Appius Claudius Crassus, known later as Cœcus (the blind). For the first eighteen months he had as his colleague the censor C. Plautius, known as Venox (the searcher of springs). Appius induced his colleague to resign under the impression that he (Appius) would do likewise. Appius kept his office, however, and managed by various contrivances to have it extended until he had the honor of giving his name, not only to Rome's first aqueduct, but, also, to the famous Appian Road, leading from Rome to Capua.

The Aqua Appia was about 10 miles long and was constructed underground with the exception of an arcade 60 paces long at the city's wall. Springs that may still be seen at the bottom of some stone-quarries near the Anio River were its source. At a later period the emperor Augustus brought some other springs into this aqueduct by means of a branch conduit, which joined the main aqueduct within the limits of the city. The junction of the two conduits was known as "the twins."

The second aqueduct was built 272–269 B. C. and was known as the Anio Vetus (Old Anio). It tapped the Anio River about twenty

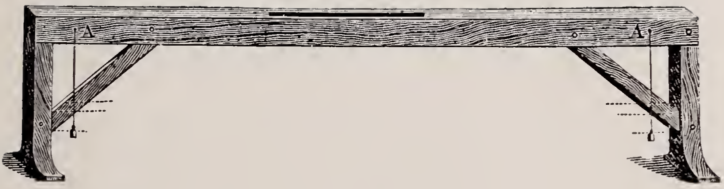


Fig. No. 1.—Roman Level.

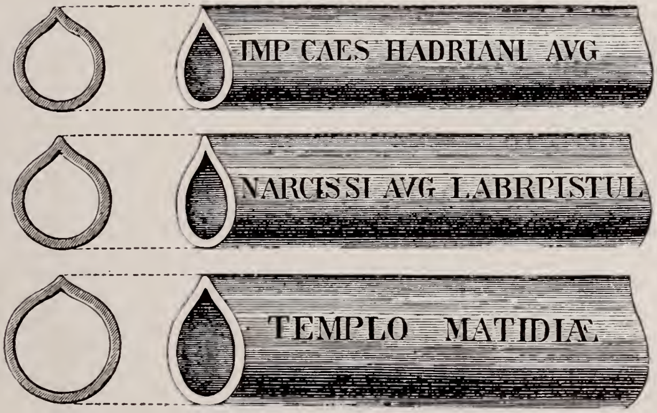


Fig. 2.—Roman Pipes.

miles east of Rome, but owing to its circuitous location it had a length of about 40 miles. With the exception of a length of a fifth of a mile, it was constructed below ground. The expense of its construction was defrayed out of the spoils of the Pyrrhic War. It was built under the direction of the censors Manius Curius Dentatus and Fulvius Flaccus.

About 125 years later (144–140 B. C.) a third aqueduct—the famous Aqua Marcia—was built, as the existing supply had become inadequate on account of the increase of consumption, and the loss of water by leakage and unlawful diversion. The Senate commissioned the prætor Q. Marcius Rex to repair the old conduits and to build a new aqueduct, which was named after him. Springs in the mountains near Subiaco, known for their coolness and salubrity, were chosen by Marcius as the source of the new conduit, although many citizens were strongly in favor of drawing the water supply from the Anio.

The new aqueduct had a length of about 57 miles, 50 miles of which was constructed below ground. It gave Rome its best supply. Pliny says: "Of all the waters in the world that which we call the Marcia, in Rome, carrieth the greatest name by the general voice of its citizens, in regard both to its coldness and salubrity, and we may esteem this water one of the greatest gifts the gods have bestowed on our city."

Fifteen years later (125 B. C.) the Aqua Tepula (tepid water) was introduced into Rome by the censors C. Servilius Cæpio and L. Cassius Longinus. Springs in the volcanic rocks southeast of the city formed its source. It was about 12 miles long and was constructed about half above and half below ground. It was carried into the city on top of the arches of the Marcian Aqueduct.

Ninety-two years later (33 B. C.) the Aqua Julia, named in honor of the emperor Julius Cæsar Augustus, was built by the ædile M. Vipsannius Agrippa to derive a supply from springs near the source of the Aqua Tepula. This conduit, which was about 14 miles long, was built for part of its length on top of the Tepula, so that at the walls of the city the Marcian arches carried three aqueducts, one above the other, *viz.*, the Marcia, Tepula and Julia.

About fourteen years later (19 B. C.) the ædile Agrippa, mentioned above, brought to Rome the Aqua Virgo. This aqueduct owed its name to the fact that a young girl (virgo) pointed out the springs which formed its source to some soldiers who were seeking for water. This conduit was about 13 miles long, being, with the exception of a mile's distance, entirely under ground.

The aqueducts thus far described had their sources to the east of Rome. About 10 B. C. the emperor Cæsar Augustus had waters from Lake Alsietinus, lying about 14 miles northwest of the city, introduced by a conduit 20 miles long, constructed almost entirely below ground, known as the Aqua Alsietina. As this water was unwholesome and at a low level, the emperor's main object in introducing it was probably to supply the Naumachia (an artificial oval lake 1 742 ft. long by 1 161 ft. wide, prepared for exhibitions of sham naval battles). In emergencies, however, it was used for domestic supply in the ward where it entered the city.

Owing to the increase of population and luxury, two more aqueducts were constructed, 38–52 A. D. They were commenced by the emperor Caligula and were completed by the emperor Claudius, after whom one of these conduits was named the Aqua Claudia. It brought water from two fine springs, about 38 miles from Rome, called Cæruleus and Curtius. This conduit was about 43 miles long, 9 miles of its length, including about 6 miles near Rome, being built above ground.

The second of these aqueducts was the Anio Novus (New Anio). It tapped the Anio River on the Sublacensian Road, about 42 miles from Rome. As the river carried at this point a great deal of sediment after storms, a settling basin was constructed up stream from the intake, to clarify the water before it entered the conduit. In spite of this precaution the water reached the city much discolored during heavy rains. The Anio Novus was about 54 miles long and was constructed below ground, with the exception of 9 miles of its length, where it was carried by arcades.

The nine aqueducts described briefly above supplied Rome with water about 97 A. D., when the emperor Nerva Augustus appointed Sextus Julius Frontinus Curator Aquarum—caretaker of aqueducts, or, as we would say nowadays, Commissioner of Water Supply.

Frontinus[*] was a very systematic, conscientious official, who tried

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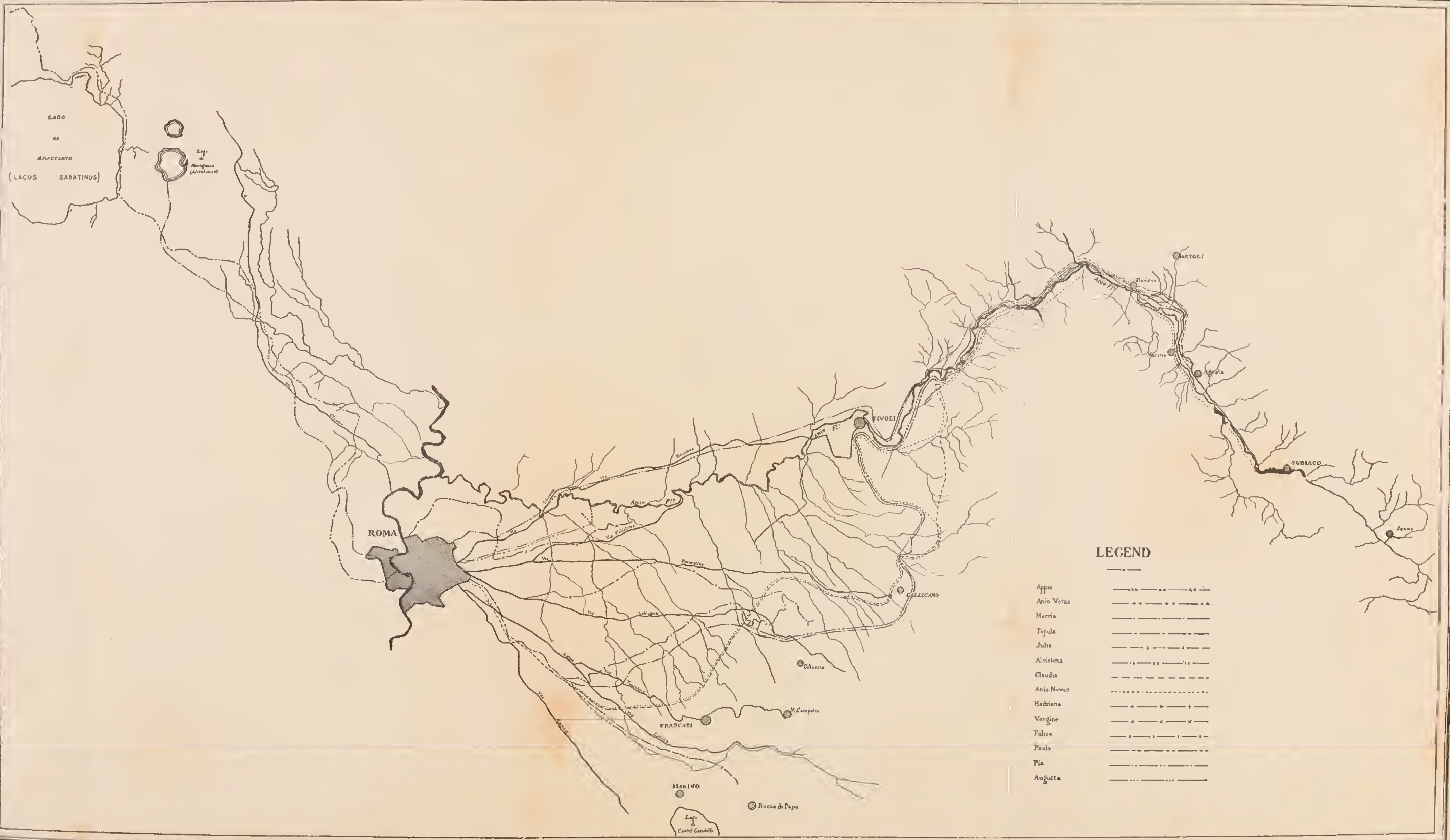
[*] Mr. Clemens Herschel, M. Am. Soc. C. E., has gathered in his book, "Frontinus and the Water Supply of Rome," all that is known of the life of Frontinus, who is mentioned by some of the ancient writers. He was born of a Patrician family about 35 A. D., was made prætor (an honorable office) in 70 A. D., was three times consul, distinguished himself as a soldier, and was made governor of Britain. Before writing his description of the aqueducts, he had written treatises on "Surveying" and on "The Art of War." He died in 107 A. D.


LAGO DI BRACCIANO
(LACUS SABATINUS)
Lago di Martignano (Alsietinus)
ROMA
TIVOLI
Anio Fl.
ARSOLI
Roviano
Marano
Agosta
SUBIACO
Jenne
GALLICANO
Colonna
M. Campatri
FRASCATI
MARINO
Rocca di Papa
Lago di Castel Gandolfo
Via Collatina
Via Praenestina
Via Labicana
Via Latina
LEGEND
Appia
Anio Vetus
Marcia
Tepula
Julia
Alsietina
Claudia
Anio Novus
Hadriana
Vergine
Felice
Paolo
Pia
Augusta

hard to introduce reforms in his department. He gauged the discharge of the nine aqueducts, according to the limited knowledge of his time, endeavored to stop the abuses that existed in the distribution of the water, and wrote a treatise giving the history and a detailed description of each of the nine aqueducts. His book, which has been translated into German, French, and recently, by Mr. Clemens Herschel, M. Am. Soc. C. E., into English, is read by engineers with as much interest to-day as when first written.

The principal data of the nine aqueducts, based mainly upon Frontinus' description, are given in the following table:

ROMAN AQUEDUCTS DESCRIBED BY FRONTINUS.

Name.	Date.	LENGTH IN MILES.			Height of water above quay of Tiber, in feet.	Number of castella.	Total supply in quinariæ.
		Below ground.	Above ground.	Total.			
Appia	312 B. C.	10.23	.06	10.29	27.5	20	704
Anio Vetus	272-269 "	39.33	.20	39.53	82.6	35	1 610
Marcia	144-140 "	49.87	6.86	56.73	123.0	51	1 935
Tepula	125 "	5.51	6.44	11.95	125.4	14	445
Julia	33 "	7.75	6.44	14.19	130.3	17	803
Virgo	19 "	11.83	1.14	12.97	34.2	18	2 504
Alsietina	10 (?) "	19.96	.33	20.29	....	....	392
Claudia	38-52 A. D.	33.31	9.35	42.66	155.6	92	5 625
Anio Novus	38-52 "	45.32	8 64	53.96	155.9		
		223.11	39.46	262.57		247	14 018

Some additional aqueducts and branch conduits were built subsequent to Frontinus' time.

The Aqua Trajana was constructed by the emperor Trajan, in 109 A. D., to bring water from springs north of Lake "Sabatinus" (now Lago di Bracciano) into the city. At a later period this aqueduct drew water direct from Lake Sabatinus. It delivered its supply on top of the Janiculum at a much higher level than the Aqua Alsietina. Towards the end of the fourth century this aqueduct was called Aqua Sabatina. The conduit was constructed mainly underground, but near Rome it was carried by arcades. Both the conduit and arches were faced with "opus reticulatum" (reticulated work), a kind of facing for masonry, consisting of small square stones, about

6 ins. square, laid lozengewise, *i. e.*, with the lines joining the opposite corners either vertical or horizontal.

The Aqua Hadriana was built in 120 A. D., by the emperor Hadrian, probably, originally only to supply his great villa near Cento Celle, about 5 miles from Rome. At a later period, about 226 A. D., the conduit was extended into Rome. In the third century it became almost filled with deposit. The emperor Alexander Severus restored and repaired the aqueduct. Perhaps it was he who extended it into Rome. On account of the work done by Alexander Severus the conduit has been called by some writers erroneously the Aqua Alexandrina.

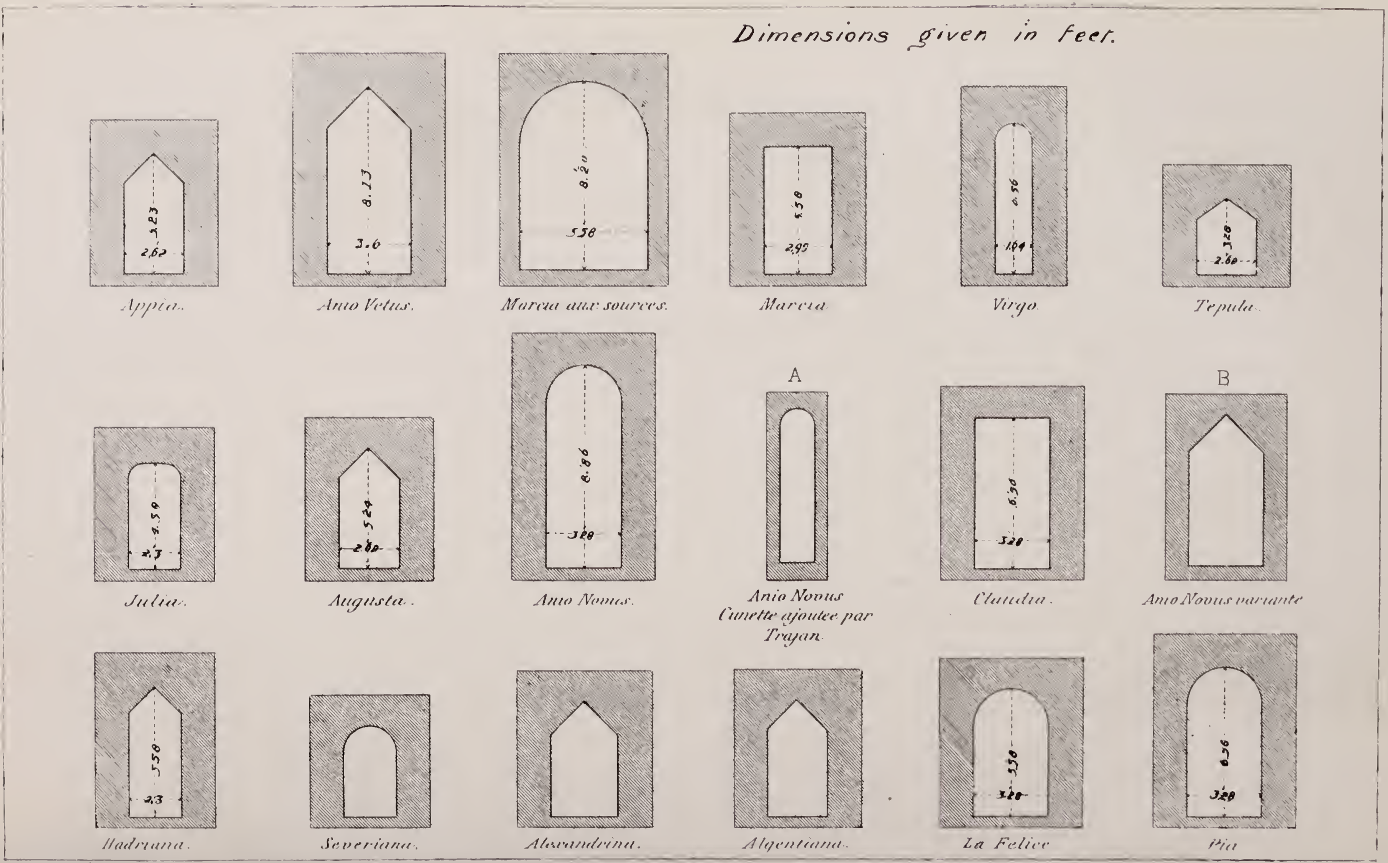
The supply of the Hadriana was derived from springs near La Colonna (ancient Labicum). The reservoir (castellum) in which the water was collected is still in perfect condition. A rough wall divides it into two chambers. Instead of following the location of the older aqueducts, the conduit made a big curve to the north, which caused it to cross a number of lateral valleys in their lower parts, where their cross-sections were deep and wide. This necessitated very expensive arcades. Some writers have thought that this departure from the rational location of the older aqueducts was caused by the desire of the architect, or perhaps of the emperor himself, to build great arcades.

The Aqua Aurelia was built in 185 A. D. by Marcus Aurelius to convey water from springs near Mariano to his villa on the Via Appia, called Villa de Quintilii. It was an important conduit, built of brick. The exposed portions have all been torn down for the building material they contained, but the aqueduct can still be seen where it is in tunnel, and the ruins of a number of its reservoirs exist.

The successors of Marcus Aurelius, Aurelius Commodus and Septimius Severus, extended the Aqua Aurelia to Rome (196 A. D.) in order to supply the great thermæ they built in the first regio (ward) of the city. The conduit took then the name of Aqua Severiana.

Besides the twelve main aqueducts mentioned above, a number of branch conduits were constructed.

About the fifth or sixth century Procopius, the secretary of Justinian I, who wrote a history of the Gothic war, visited Rome with Belisarius. He speaks about the city being supplied by fourteen aqueducts. This statement has puzzled archæologists a great deal.


Dimensions given in feet.
3.23
2.62
Appia.
8.13
3.6
Anio Vetus.
8.20
5.58
Marcia aux sources.
5.58
2.95
Marcia.
6.56
1.64
Virgo.
3.28
2.60
Tepula.
4.59
2.3
Julia.
5.24
2.60
Augusta.
8.86
3.28
Anio Novus.
A
Anio Novus
Cunette ajoutee par
Trajan.
6.30
3.28
Claudia.
B
Anio Novus variante
5.58
2.3
Hadriana.
Severiana.
Alexandrina.
Algentiana.
5.50
3.28
La Felice
6.56
3.28
Pia

Authorities disagree as to just how many main aqueducts were in existence at that time. In all probability there were only the twelve aqueducts described above, and the others that were counted by Procopius were probably branch conduits.

Having given briefly the history of the aqueducts that supplied ancient Rome, we shall now enter more into detail in describing their construction.

Sources of Supply.—The Old Romans were very particular about selecting good sources for their domestic supply, giving the preference to springs over surface water. Six of the nine aqueducts described by Frontinus drew their supply from springs. Fortunately for Rome there were many copious springs of wholesome water within 20 to 40 miles of the city in the volcanic rocks to the southeast and the limestone of the Apennines to the northwest. From the latter place came the best drinking water, although its hardness would nowadays make it objectionable for industrial purposes. In selecting a source of supply the Old Romans judged its quality by the health of the people who had been using it and the hardness shown in cooking vegetables.

The location of the nine aqueducts of Frontinus' time and of some conduits built later is shown on Plate I. The alignment of the Appia, Tepula, Julia and Alsietina is simple and direct. The Virgo made a a long curve to reach the northern part of the city. The location of the long aqueducts coming from the Apennines (Anio Vetus, Marcia, Claudia and Anio Novus) must have involved considerable skill, especially as the Romans had no suitable material for making large siphon pipes. Not many years ago it was thought that the many arcades built by the Romans proved that they did not understand the principle that water will seek its level, but this was far from the truth. Many lead siphon pipes were used in distributing the water in Rome, and a deep valley on the main line of the aqueduct of Lyons (France) was crossed by twelve lines of such pipes. The reason why large siphon pipes were not used was on account of the cost and weakness of lead, the only material used by the Romans for making pipes. As the Roman engineers had to omit siphons and to avoid high arcades they laid out their aqueducts on much more sinuous courses than modern engineers would adopt.

The grades adopted for the old Roman aqueducts were much steeper than those of modern conduits. The grades of the nine aqueducts of Frontinus' time have not been accurately determined. In Roman aqueducts in other parts of Europe the grades are found to vary from 1 : 3 000 to 1 : 600.

In some of their conduits the grades are quite regular, while in others they are quite the contrary.

One reason why such steep gradients were adopted was to cover errors in leveling with the very primitive instruments that were used. Vitruvius, an architect and engineer, who lived about the beginning of the Christian era, has explained the construction of the Roman level instruments. One kind was a water-level, consisting of a tube, probably of copper, about 5 ft. long, having its ends turned up and being filled with water. By sighting a certain distance above the water shown in the two ends a level line could be produced. The most reliable instrument was the "chorobates" (Fig. 1), a straight-edge about 20 ft. long, having a small water-channel about 5 ft. long in the middle. By filling this channel partially with water, the instrument could be roughly leveled, but the main reliance was placed on two plumb-bob lines, one at each end, which had to agree with scratch-marks on the instruments, when the latter was level.

Details of Construction.—The cross-section of the water-channel was not always the same in different parts of the same aqueduct, and varied probably according to the grades. Plate II shows the cross-sections of the nine aqueducts, as given by M. Belgrade in his book "Les Aqueducs Romains," Paris, 1875. It will be noticed that no two sections are alike.

The first aqueducts were built almost entirely in tunnel. Where rock was encountered, it was either removed by chiseling and wedging, or by the "fire-setting" system, which consisted in heating the rock by means of fire and of cooling it suddenly with water. Some ancient writers have recommended the use of vinegar, instead of water, for cooling the rock. The "fire-setting" system has been used until recent times in some German mines.

The tunnels were made by means of numerous shafts. In the Aqua Virgo they are 240 ft. apart, a distance corresponding to an old Roman measure, and can be readily found, as a strong growth of vegetation occurs at their sites on account of the moisture they collect. The shafts enable us to trace the location of the aqueducts.

PLATE III.

Aqua Marcia, near Rome.

PLATE IV.

Aqua Marcia, at Wall of Aurelius.

The early aqueducts were built entirely of dry-cut stone masonry, with the exception of a lining, 4 to 6 ins. thick, for the water channel, which consisted of a kind of concrete (opus signinum) made of pottery pounded into small pieces and mixed with quicklime and sand. At a later period rubble and brickwork were used. The Roman bricks were triangular in shape and about 1½ ins. thick.

The bottom of the water channel was left rough, probably to reduce the velocity of the current, to aerate the water, and to keep back sediment.

Perhaps it was also with a view of checking the velocity and aerating the water that the numerous angles were introduced which we find in the location of the aqueducts (see Plate XII). In some of the conduits they are about half a mile apart. Some writers have thought, however, that the angles may have been made on account of difficulties in securing the right of way.

At each of the angles a small reservoir (castellum) was built, and sometimes a settling basin (piscinæ). These reservoirs served for distributing water along the line of the conduit, where required, and also, as blow offs. The piscinæ or settling basins had two upper and two lower chambers. The water entered the first (upper) chamber, passed down (probably through a pipe) into the lower chamber below it; flowed through numerous small holes in a partition wall into the second lower chamber, and rose, then, through a hole in the roof of the chamber into the second upper chamber. By compelling the water to flow in this circuitous manner, a great deal of the coarse sediment was deposited in the lower chambers. Sluices were placed in the partition-wall between the two upper chambers. When they were opened, the water could flow direct through the upper chambers, without passing through the lower ones.

Ventilators (lumina) were built at frequent intervals along the aqueducts and were provided with steps for entering the conduit. Sometimes they served as wells from which water was drawn from the aqueducts by means of buckets.

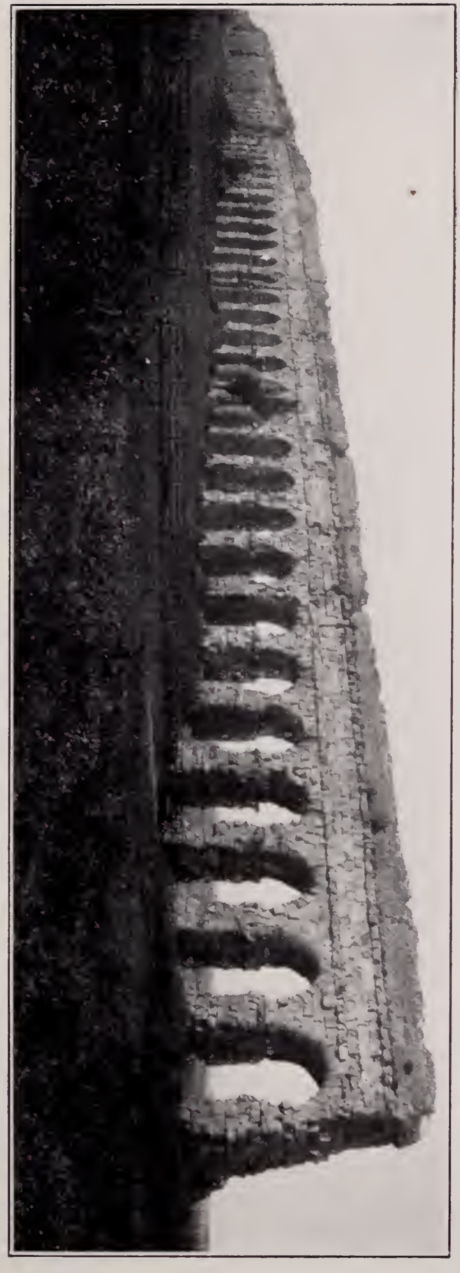
Distribution of Water.—The aqueducts terminated in Rome in large reservoirs (castella publica), some of which received the water of several conduits. From these reservoirs the water was conveyed in leaden pipes to smaller reservoirs or cisterns (castella privata), which were built at the expense of several water takers, who clubbed together for this purpose. From these reservoirs the water was taken in lead pipes to the domestic cisterns (usually made of lead), which were placed in the courtyards of the houses. In the time of Frontinus there were 247 public and private castella. Ruins of many of these reservoirs are still to be seen in Rome.

The quantity of water flowing in and out of each reservoir was measured by the size of pipe or pipes through which the water passed. The quantity that could be drawn to each domestic cistern was regulated by a short, bent tube of bronze or brass, called a calyx, which was inserted in the side-wall of the reservoir and formed the inlet to the service pipe.

These tubes were made originally of lead, but as the aquarii (water-men) were able to increase or diminish the flow by extending or compressing the lead, a harder metal (bronze or brass) was used for the calyces to prevent fraud. The Romans were well aware of the fact that a short tube (adjutage), whose length is only two or three times its diameter, will discharge more water than an orifice or a long tube of the same diameter. To prevent consumers from drawing more than their share of water by using a short calyx joined to a service pipe of larger diameter, the Senate passed finally a law requiring the service pipe to have the same diameter as the calyx for at least 50 ft., from the castellum.

The service pipes of Rome were generally made of lead, although Vitruvius states that this metal made the water unwholesome. The calyces were always made circular, but the leaden pipes were always given a piriform shape (Fig. 2). This may have been due to the fact that these pipes were made of sheet lead, which, when bent to a piriform shape, facilitated the forming by means of clay of a small channel on top, into which molten lead was poured to form the longitudinal joint. The individual pipes were uniformly 10 Roman ft. (9.8 English ft.) long, and were made of sheets of lead about a quarter of an inch thick. The joints between adjoining pipes were made either by expanding the end of one pipe and inserting the end of the other or by means of a sleeve covering the joint and made tight by pouring lead. The Romans had no solder; the lead they used for the joints of pipe was simply a mixture of different kinds of lead.

The name of the contractor, and frequently, also, of the house-owner, was stamped on each pipe.



Aqua Claudia, near Rome.

Consumption of Water.—Frontinus, while in charge of the water supply of Rome, made careful measurements to determine the discharge of each aqueduct. He recorded in his description of the nine aqueducts the wetted area of each conduit at the time he gauged it, but, unfortunately, paid no attention to the velocity of the water and omitted to state whether the summer in which he made his observations was a dry, wet or average season.

Frontinus divided the wetted area of each conduit by the area of the calyx generally used for domestic supply, known as a quinaria, as its area was equal to that of five smaller pipes used for that purpose before the quinaria was introduced. This calyx had an area of 0.632 sq. in. Frontinus gave the capacity of each conduit by stating that it was equal to so many quinariæ, just as though we should say an aqueduct is equal to so many 1-in. pipes. Knowing the area of a quinaria to be 0.632 sq. in., we could easily convert the delivery of each aqueduct into U. S. gallons, if we only knew the average velocity of the water. As Frontinus does not give us this important factor, we must either estimate it from certain assumptions or by measuring the hydraulic gradients in the remains of some of the aqueducts, which can be readily done by the marks of incrustation or by estimating the yield of some of the sources of the old conduits.

M. Prony stated, in the *Mémoires de l'Académie Royale*, Vol. II of 1817, that, if we assume the head acting on a quinaria calyx to be equal to its length (a custom existing in Rome in 1810) and that the calyx discharges freely into air, the discharge of the quinaria would be about 16 000 U. S. galls. in 24 hours. M. Rondelet, a French engineer, adopted Prony's assumptions, and, by multiplying the assumed discharge of a quinaria by the number of these pipes given by Frontinus for the nine aqueducts, found the water supply of Rome, 97 A. D., to have been about 393 000 000 U. S. galls. for a population of about a million. This astonishing figure, which was based upon assumptions which were probably far from the truth, especially as regards the delivery of the short quinaria calyx into free air, instead of into a long pipe, was largely quoted in encyclopædias, etc., and astonished the world until M. Belgrand, for many years Chief Engineer of the Water Supply of Paris (France), pointed out in his book, "Les Aqueducs Romains," the fallacy of Rondelet's estimate.

Belgrand endeavored to calculate the probable discharge of the nine Roman aqueducts in a more scientific way. Taking the wetted areas measured by Frontinus and knowing the cross-sections of the conduits (Plate II), he was able to calculate the wetted perimeters. The only elements lacking now for calculating the discharges were the grades. For a few of the aqueducts near Rome these had been determined by M. Rondelet. For the Marcia, Claudia and Virgo he had accurate figures of probable discharge made by Col. Bernard Blumenstihl, the Chief Engineer of the Aqua Pia, a modern aqueduct bringing again the famous Marcian water into Rome. For the Alsietina he took, for lack of definite data, the erroneous estimate of Rondelet, as the resulting error would not have a great effect on the total delivery of the nine aqueducts.

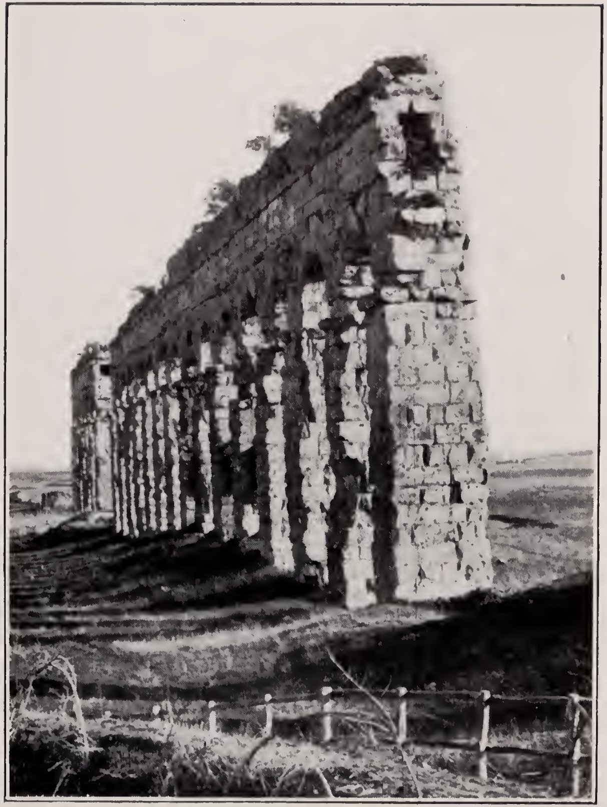
Belgrand's estimate of the water supply of Rome was 251 720 000 U. S. galls., but he thought that even this figure was probably too high.

Mr. Clemens Herschel estimates that the discharge of a quinaria may have varied, according to circumstances, from 2 500 to 9 000 U. S. galls. in 24 hours. Assuming, to be liberal, an average discharge of 6 000 galls in 24 hours, Mr. Herschel finds the discharge of nine aqueducts to be 84 108 000 galls., of which quantity, according to Frontinus' subdivisions, about 54 000 000 galls. was distributed within and the remainder without the city.

We know from Frontinus' account and, also, from what Pliny says, that, at times, one to three of the aqueducts failed for long periods to bring any water into Rome, either on account of necessary repairs or because the water was unlawfully diverted. Making allowance for this, the quantity of water actually delivered in the city may not have been more than about 40 000 000 galls. or 40 galls. per capita, instead of 393 galls. per capita, according to Rondelet. Herschel's figure is still large when we consider that most of the water used by the Romans for domestic supply had to be carried into their houses in jars on the heads of slaves.

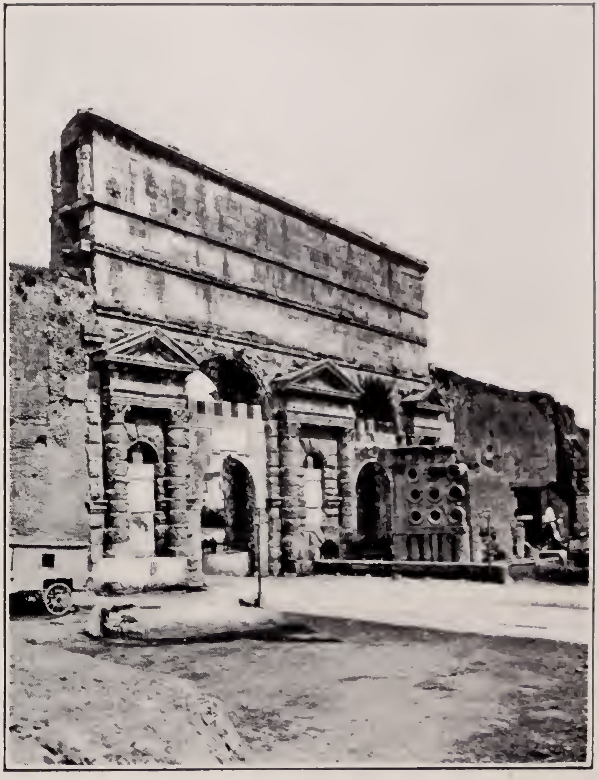
Frontinus states in detail how the water was distributed. He tells us which of the fourteen regiones (wards) into which Augustus divided Rome were supplied by each aqueduct; how many quinariæ were consumed without and how many within the city, and how much water was used for public and how much for private service. The quantity used for public service he subdivides into what was required for the

PLATE VI.



Aqua Claudia.

PLATE VII



Porta Maggiore.

soldiers' camps, the public works, the places of amusement and the fountains and ponds. However faulty the method of gauging may have been, the water register appears to have kept very detailed accounts.

The aqueducts of Rome were built at different intervals of time, according to the demand for an increased water supply. To make this available in different parts of the city, each aqueduct distributed its water by branch conduits over a considerable portion of the city. This introduced a multiplication of branch conduits which would have been, of course, avoided if the aqueducts had been built at about the same time. From the table on page 29, it will be seen that with but two exceptions each aqueduct delivered its water at a higher level than those previously built. Had the light grades of modern aqueducts been adopted (*viz.*, ½ to 1 ft. per mile), the Roman aqueduct having the least head might have delivered its water at the level of the highest conduit.

The care of the aqueducts was given during the republic to Ædiles and Censors. Augustus confided this work to a curator aquarum (commissioner of water supply). Marcus Agrippa was the first person appointed to this office. Frontinus held it under Domitian, Nerva and Trajan. In the third century the charge of the aqueducts was given to Consulares Aquarum, a title that was changed in the fifth century to Comes Formarum Urbis.

The official in charge of the water supply of Rome held a very responsible position. Frontinus had under him 700 aquarii (watermen), who were employed in guarding, repairing or cleaning the aqueducts and reservoirs. Two hundred and forty of these aquarii were appointed by the City Government and the others by the Emperor.

Repairs and Restorations of the Aqueducts.—The Romans were very careless about maintaining their aqueducts. Necessary repairs were often postponed until a conduit failed to deliver any water. In the time of Pliny the Julia, Marcia and Virgo were in this condition. The Claudia and Anio Novus, completed in 52 A. D., did not deliver any water into Rome from 62 to 71 A. D.

Frontinus mentions, as the causes of the extensive repairs which the aqueducts required from time to time, the age of some of the conduits, poor work in the original construction, the effects of the weather, the damages caused by roots of trees near the aqueducts growing into the conduits, and the unauthorized tapping of the aqueducts by the land owners through whose properties they had been built. Pliny writes about the Marcian water being fraudulently diverted in his time (60–70 A. D.) as follows: "We of Rome have lost the pleasure and commodity of those rills through the ambition and avarice of some great men, who have turned away the waters from the city where they yielded a public benefit to the commonwealth and have diverted them, for their own profit and delight, into their own manors and houses, to irrigate their gardens and for other uses." According to law the aquarii were allowed to sell all water that leaked from the conduits. It was in their interest, therefore, to encourage rather than to check a leak.

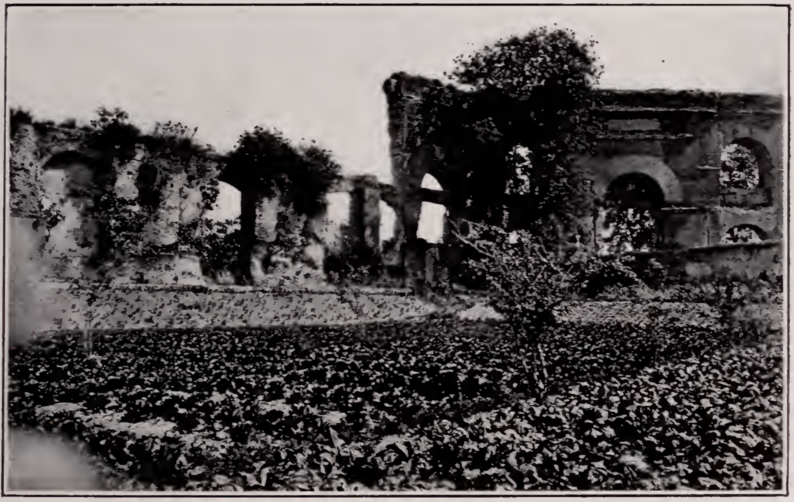
Another cause of the neglect of the aqueducts was the law which required the Curator Aquarum to give only a quarter of his time to his official duties. These officers utilized their leisure often by taking private contracts on which they employed the aquarii.

Some of the arcades near Rome were much injured by an earthquake that occurred in 63 A. D. They were reinforced by building brick arches under the original stone arches.

Very extensive repairs were undertaken from time to time. They had to be authorized by the Senate and the limits within which they were made were marked by small columns. A number of these columns have been found in the ruins of Rome. From their inscriptions it appears that some of the repairs were made on stretches of 6 000 to 15 000 ft. Among the emperors mentioned in these inscriptions as repairing or restoring aqueducts we find Augustus, Tiberius, Vespasian, Titus, Domitian, Severus, etc. In making the repairs the location of an aqueduct was sometimes improved by constructing a new structure or driving a tunnel to obtain a shorter line.

Tunneling in Ancient Times.—We have already mentioned on page 32 how the ancients constructed their tunnels. In this connection it may be of interest to give a correspondence which took place about 152 A. D., which proves that the ancient engineers had their trials as well as their modern professional successors. The correspondence is given by Lanciani in his "Ancient Rome," and we quote it as given by Mr. Clemens Herschel in his book on "Frontinus," etc. The correspondence commences thus:

PLATE VIII.



Nero's Arches.

"Varius Clemens, governor of Mauritania,* to Valerius Etruscus, governor of Numidia:*

Varius Clemens greets Valerius Etruscus, and begs him in his own name, and in the name of the township of Saldae (Algeria), to dispatch at once the hydraulic engineer of the third legion, Nonius Datus, with orders that he finish the work, which he seems to have forgotten."

Report of Nonius Datus to the magistrates of Saldae:

"After leaving my quarters I met with brigands who robbed me of even my clothes, and wounded me severely. I succeeded, after the encounter, in reaching Saldae, where I was met by the governor, who, after allowing me some rest, took me to the tunnel. There I found everybody sad and despondent; they had given up all hopes that the two opposite sections of the tunnel would meet, because each section had already been excavated beyond the middle of the mountain, and the junction had not yet been effected. As always happens in these cases, the fault was attributed to the engineer, as though he had not taken all precautions to insure the success of the work.

What could I have done better?

I began by surveying and by taking the levels of the mountain; I marked most carefully the axis of the tunnel across the ridge; I drew plans and sections of the whole work, which plans I handed over to Petronius Celer, the governor of Mauritania; and to take extra precaution, I summoned the contractor and his workmen, and began the excavation in their presence, with the help of two gangs of experienced veterans; namely, a detachment of marine infantry and a detachment of Alpine troops. What more could I have done? Well, during the four years I was absent at Lambæse, expecting every day to hear the good tidings of the arrival of the water at Saldae, the contractor and his assistant had committed blunder upon blunder; in each section of the tunnel they had diverged from the straight line, each towards his right, and had I waited a little longer before coming, Saldae would have possessed two tunnels instead of one."

Nonius Datus, having resurveyed the work, joined the two parallel tunnels by a transverse tunnel. The waters of the river could finally flow through the mountain, and its arrival at Saldae was celebrated with great rejoicings in the presence of the governor, Varius Clemens, and the engineer.

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* Neighboring colonies in Africa, in the Carthaginian country.

Details of Construction.—Having given a general description of the water-works of Ancient Rome, we will now examine the details of the construction of the works a little more closely, illustrating them by reproductions of photographs, most of which were taken specially for the writer of this paper, by Mr. Howard Crosby Butler, A. M., lecturer on Architecture and Archæology, at Princeton College.

The Aqua Appia was almost entirely below ground. Part of it was, doubtless, constructed in "open trench," but in some places tunneling must have been resorted to. Where this conduit entered the city, it was about 50 ft. below the surface. In the details of its construction this aqueduct is very much like the sewers and drains that had been built in Rome at an earlier period. The cross-section of the conduit was about 2.5 by 5 feet. The sides were formed of large blocks of cut stone and the cover was generally an arch, but sometimes a slab or two slabs leaning against each other like the roof of a house.

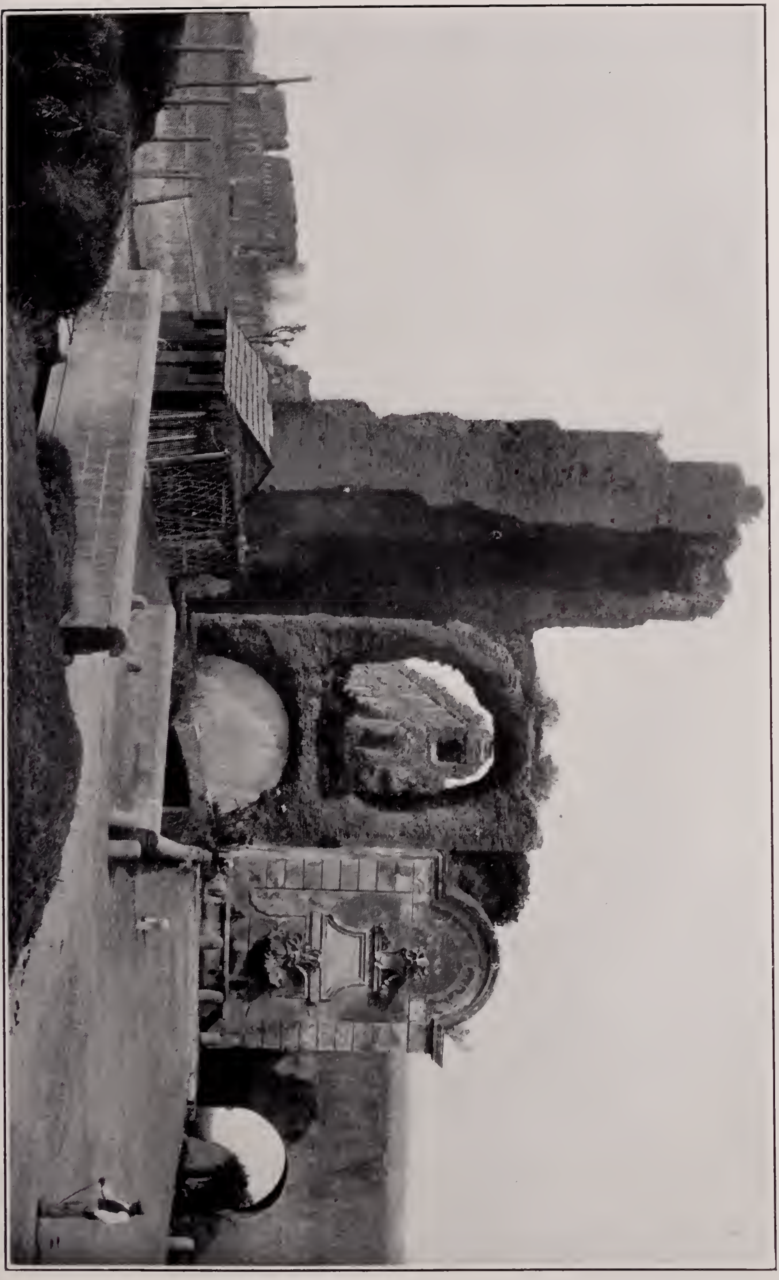
The Anio Vetus, although 55 feet higher than the Appia, was also, a low-level aqueduct constructed almost entirely below ground. It drew water from the river Anio about half a mile up stream of the monastery S. Cosimato, entered Rome at about the level of the ground near the present Porta Maggiore, and delivered its water into the city through two branch conduits. Its cross-section was 3 to 3.7 ft. wide by 6 to 8 feet high. This aqueduct was, also constructed of massive stone blocks, plastered on the water side. Owing to its being generally wholly or partly underground, but few remains of this aqueduct have been found.

The Aqua Marcia, the great aqueduct of the Republic, differed from the first two conduits by being carried by arches for a length of about seven miles. Most of these arcades have been destroyed, but fortunately enough are standing to illustrate how this aqueduct was built.

Plate 3 shows the Marcia near Rome, and Plate 4 shows it where it crosses the city wall, known as that of Aurelius. The conduit is built in a very simple manner of dimension stones, which were cut with such accuracy that a knife blade can scarcely be put in the joints. Most of the stones are tufa (a calcareous rock), but in the foundations of the piers and in the top and bottom courses of the water-channel a harder stone, peperino (a volcanic tufa) was used.

The dimensions of the arches and conduit near Rome vary but little.

PLATE IX.



Crossing of Aqueducts at the Torre Fiscale.

According to Mr. Howard Crosby Butler, M. A., they are about as follows:

	Feet.
Distance between piers	16.66–17.64
Depth of pier, parallel with center-line of aqueduct, according to height	5.74–10.50
Width of pier, at right angles to center line of aqueduct	8.55
Cross-section of conduit	3 x 5.7

The water-channel on top of the arches is built in the simplest manner, very much like a culvert. The top and bottom are formed of slabs of stone 0.82 ft. thick, projecting on either side 0.65 ft. The side walls are 1.54 ft. thick, and each consists of three equal courses of dimension stone (usually stretchers).

The voussoirs of the arches are cut very accurately. They consist alternately of one and two pieces of stone, the former extending through the entire soffit of the arch and measuring 1.77 x 1.87 x 5.64 ft.

The blocks of stone used in the piers and spandrels are practically uniform (about 2 x 2 x 4 ft.) and are laid in regular courses with headers and stretchers alternating. No mortar is used in the masonry with the exception of a plastering of opus signinum (see page 33) for lining the water-channel and of dowel-pins 0.4 ft. in diameter of fine cement that were placed in the vertical joints of the stones forming the side-walls of the water-channel. Semi-circular grooves were cut in the ends of the side-stones for these dowel-pins.

In the Tepula and Julia, built respectively in 125 and 33 B. C., we notice a great improvement in masonry. Instead of the primitive and expensive construction of cut stones, laid dry, concrete masonry faced on the outside with reticulated work (opus reticulatum) and lined on the inside with opus signinum was used.

As has already been stated, the Tepula was built near Rome on top of the Marcia, and the Julia on top of the Tepula. The cross-sections of the Tepula and Julia were, respectively, 2.7 x 3.3 ft. and 2.3 x 4.6 ft. The concrete walls are 1.54 ft. thick, and the concrete separating these two aqueducts is about 1.31 ft. thick.

The Julia has been almost entirely destroyed, but remains of the Tepula are still to be seen on top of the Marcia (Plate III).

The arches of the Marcia, Tepula and Julia were incorporated into the city wall, built by Aurelius (272 A. D.)

Plate IV shows these three aqueducts, where they cross the Porta San Lorenzo. Here all three conduits are built of dimension stone of travertine (a calcareous stone).

The Virgo and Alsietina were constructed almost entirely underground, and their construction cannot, therefore, be illustrated by means of photographs. The cross-section of the former was about 1.6 x 6.6 feet.

The Virgo supplied the baths of Agrippa and of Alexander Severus. Many large lead pipes, encased with brick, which distributed the water of this conduit, have been dug up in recent times.

The Aqua Claudia and the Anio Novus, the most imposing of all Roman aqueducts were commenced in the reign of Caligula in 38 A. D., and required fourteen years for their construction. Frontinus says that they were completed in a most magnificent manner, and were dedicated on the 1st of August, 52 A. D., the birthday of the emperor Claudius, after whom one of these conduits was named.

Pliny states that these two aqueducts cost 55½ million sestertii (nearly $3 000 000), a sum that may not seem large to a modern engineer, but which was considered high at the time, when the value of money was greater than at present, and when cheap slave labor was employed on public works.

The location of the Claudia followed generally that of the Marcia, but the length of conduit, as compared with the Marcia, was shortened by building higher arcades and by tunneling mountains. While the Marcia was nearly 57 miles long, the Claudia, whose source was near that of the Marcia, had a length of only about 43 miles.

About thirty-six years after the Claudia was completed its length was shortened by excavating a tunnel, about 3 ft. wide, 7 ft. high and 3 miles long under the mountain called formerly Mount Afiliano.* It was constructed, before Frontinus wrote his description of the aqueducts, by a contractor named L. Paquedius Festus, who appears to have realized that he had undertaken rather a difficult contract. In order to propitiate the gods Festus promised, according to an inscription still preserved, to restore a temple on top of the mountain he was tunneling if he succeeded in his work. He

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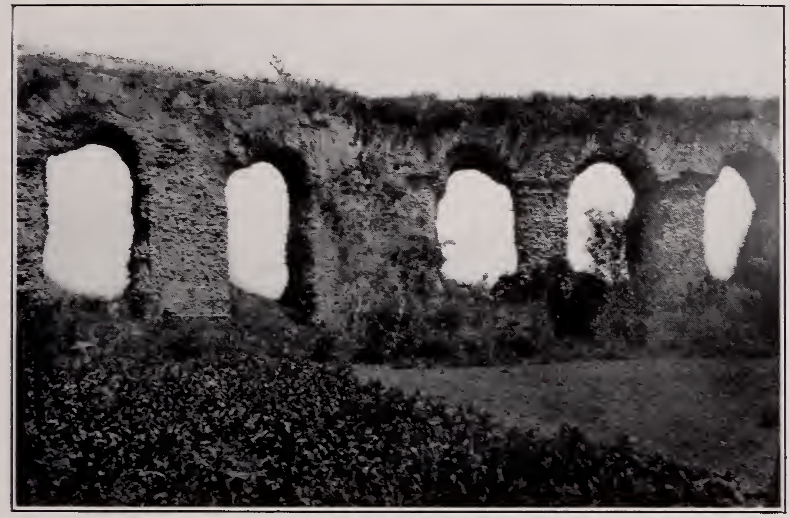
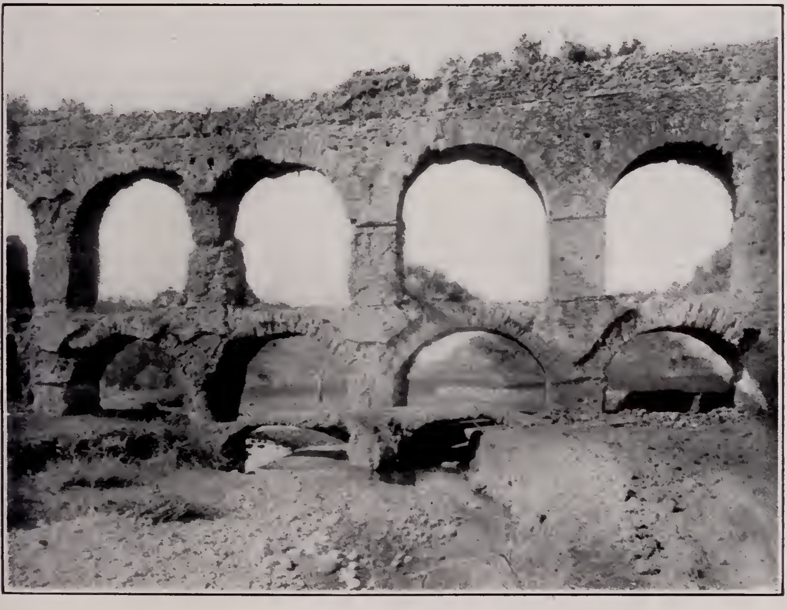
* See Lanciani, "Ancient Rome" ch., p. 62.

PLATE X.



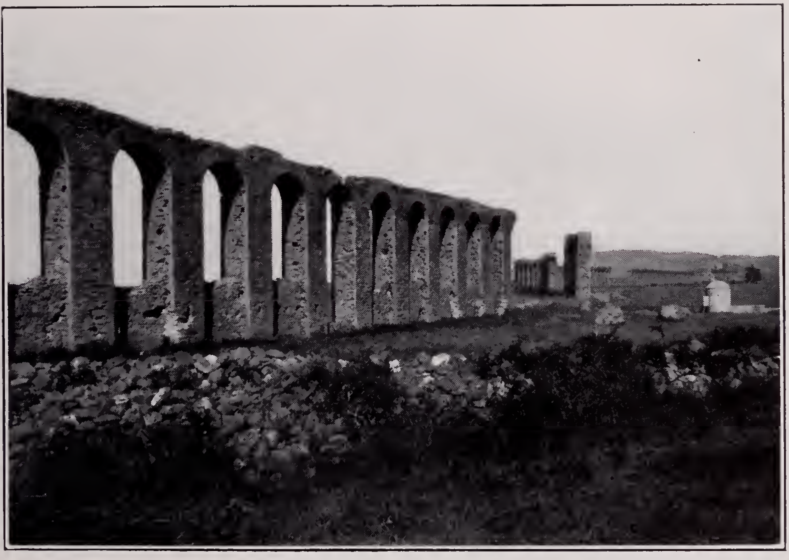
Aqua Hadriana.

PLATE XI.



Ponte San Antonio.

PLATE XII.



Aqueduct of Quintilii.

pierced the mountain successfully, July 3d. 88 A. D., and the remains of beautiful columns and statuary on the summit of the mountain have led archæologists to infer that Festus kept his vow.

The ruins of the Claudia are much more extensive than those of the other aqueducts. Groups of from four to eighteen arches stand intact all the way, from the Porta Maggiore of Rome to Roma Vecchia, where an arcade of 154 arches begins that continues almost to the point where the acqueduct goes below ground. The details of the construction can, therefore, be studied to advantage.*

The Claudia was built very much like the Marcia, but on a larger scale. The stone used was principally peperino, with red and yellow tufa in smaller proportions. The quality of the stone does not appear, however, to have been as good as that used in the Marcia, and in some places it is crumbling to decay. No travertine or other harder material was used for bonding the courses. The stones were not cut as accurately as in the Republican Aqueduct (the Marcia), perhaps on account of the greater friability of the stone, but much larger blocks were used. Some stones extend entirely through the piers, and are about 10 ft long. No mortar was used in the construction, except for the plastering of the water-channel. The courses of the stones are of unequal height, averaging about 2.2 ft. Each arch is composed of seventeen voussoirs. A few of these are single stones, but there are usually two or three pieces to each voussoir in the soffit.

The piers begin with a base of hard peperino, which projects about 0.49 ft. from the faces of the pier. Above this the piers are carried up with a mean width of 10.53 ft., and a depth, measured parallel with the axis of the conduit, of 10.98–12.01 ft. The piers are, therefore, almost square in plan. They do not vary, according to the height of the arcade. Below the springing line of the arches each pier has an overhanging course, which forms a heavy impost moulding 1.15 ft. deep, which is the only embellishment used, and serves to break the transition from the pier to the arch construction.

The arches have spans of about 18.37 ft. They are only 8.27 ft. wide, and the distance between the intrados of two adjoining arches is only 8.53 ft., so that the impost is much smaller in section than the pier.

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* The dimensions, etc., given in the description are taken from a paper on "The Roman Aqueducts as Monuments of Architecture," by Mr. Howard Crosby Butler, M. A., published in the *Journal of the Archæological Institute of America*, Vol. V, 1901.

The course which forms the bottom of the water-channel (specus) consists of rubble laid in cement, placed direct on the voussoirs and projecting on either side 0.72 ft. It is not moulded. The top course of the water-channel has three stones for the width of the water-channel, instead of single slabs, as in the Marcia.

Each side wall consists of three courses and is 2.13 ft. thick and 6.49 ft. high. The cross-section of the water-channel is 4 ft. wide by 6.06 ft. high, which is 42% larger than that of the Marcia.

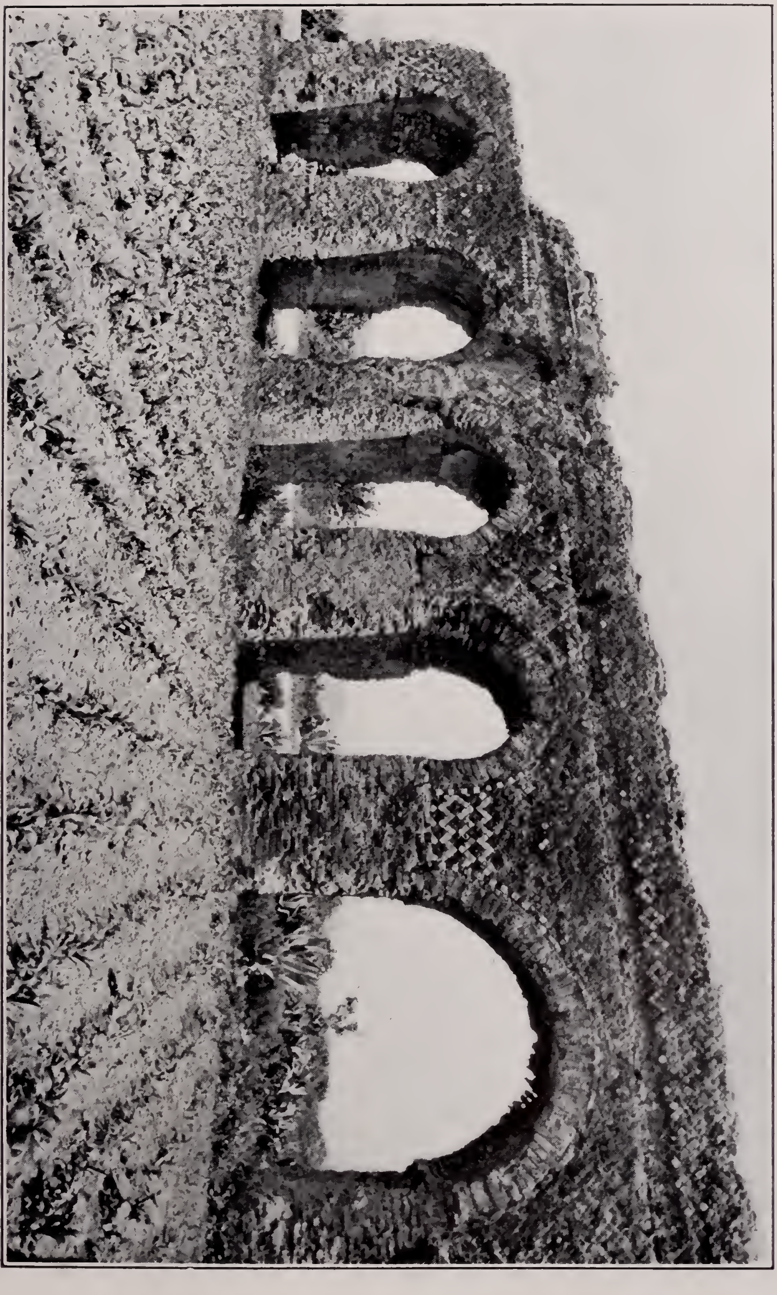
Plates V and VI illustrate the construction of the Claudia. At the highest point the top of the arcade is about 90 ft. above the surface of the ground.

Plate VII shows the celebrated Porta Maggiore (Greater Gate), at a point in Rome where the Claudia and Anio Novus Aqueducts crossed two roads. In accordance with the customs of the Romans a fine structure was built at this crossing, upon which inscriptions were cut giving the history of the work. On the Porta Maggiore we read:

"Tiberius Claudius, the son of Drusus Cæsar Augustus Germanicus, Supreme Pontiff, in the twelfth year of his tribunate and fifth consulship, proclaimed imperator (on the field of battle) twenty-seven times, the father of his country, caused to be brought into the city at his own own expense the Claudian water from the springs called Cærulius and Curtius, from 45 miles away, also Anio Novus, from 62 miles away."

Right below this inscription we read that nineteen years later (including nine years of disuse) Vespasian restored these aqueducts to usefulness. A third inscription informs us that Vespasian's son Titus did the same thing ten years later (81 A. D.).

Nero's Arches.—The waters of the Claudia and Anio Novus were mixed in a small reservoir near the city wall, and were then distributed by pipes. Nero, who succeeded Claudius (54–69 A. D.), carried these aqueducts into the city on an arcade that still bears his name. It was built entirely of brick of the best quality along the Cælian Hill as far as the arch of Dolabella, where the water was received in a large reservoir. Nero's successors built three branch conduits for distributing the water. Frontinus has given us a good description of this work, of which he had charge for many years under Nerva and Trajan. Plate VIII shows some of Nero's arches.



Aqueduct of Minturnæ.

PLATE XIV.

Crossing of Aqueducts.—The roads to Rome from the east were for the last mile between the fine arcades of the Marcia, Tepula and Julia, about 30 ft. high on the right, and those of the Claudia and Anio Novus, about 50 ft. high, on the left. The arcades were about 100 yds. apart. About three miles from the city on the road to Frascati, these two arcades crossed each other near the Porta Furba. The tower built at their intersection is known as the torre fiscale. Its ruins are shown on Plate IX.

The aqueduct at the right of the plate is the mediæval Acqua Felice, which was about parallel with the Marcia. The arcade seen in the distance is the Claudia, with the Anio Novus on top, which at the intersection was at the higher level.

The Anio Novus drew its supply direct from the Anio River at a point on the left bank, about 42 miles from Rome. We have already explained that a settling basin had to be constructed to clarify the water during floods. This basin had four cross-walls over which the water was made to pass. As it still remained muddy at times, a very pure rivulet, called Rivus Herculaneus, which rises about 34 miles from Rome, was introduced into the Anio Novus to purify the water. As the effect of this pure stream was not sufficient, the inlet of the Anio Novus was carried by Nerva or Trajan further up stream by an extension of the conduit on the right bank of the river to a larger settling reservoir, formed by building a dam across the river.

From its original inlet on the left bank of the Anio, the aqueduct commenced with a rock tunnel, 16 ins. wide and 6 ft. high. The miners must have worked sideways to cut this narrow drift. The section of the conduit is, however, afterwards increased to 3 3 ft. wide by 9 ft. high. The aqueduct was constructed principally underground, but valleys were crossed by arcades which, in some cases, had a height of 109 ft.

For the last 6 or 7 miles the Anio Novus was built on top of the Claudia, while the latter was, however, constructed for the last 6 miles entirely of cut stone, the former was built entirely of concrete and brick. The conduit is lined with brick (which were triangular, equal to half a square with sides 8 ins. long, and 1½ ins. thick) and covered with large flat tiles, which were placed so as to form a pointed roof.

In the time of Trajan, a large reservoir was constructed for this aqueduct in the city, near the mausoleum of Santa Helena. About a mile further another reservoir was built.

The supply brought by the Anio Novus, although muddy at times, was the most abundant of all, and reached Rome at the highest level. Frontinus tells us that, on account of its abundance, water from the Anio Novus was often turned into the other aqueducts (sometimes without necessity) and generally spoiled the quality of the supply.

Where one aqueduct was carried by another or crossed another, an arrangement was always made for letting the water from the higher flow into the lower conduit by removing stone plugs placed in the bottom of the higher conduit.

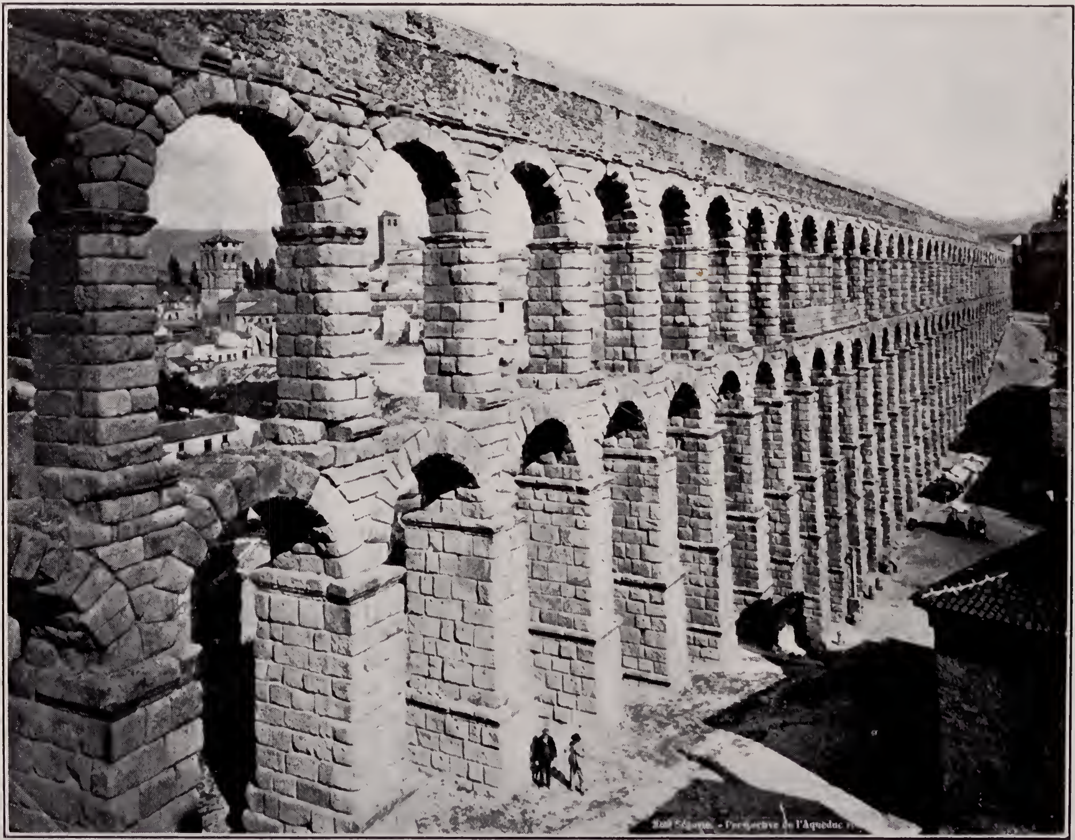
The Hadriana is shown in Plate X at one of its angle points. It differs from the earlier aqueducts in being constructed entirely of brick and concrete. Some fine ruins of this conduit are in existence, but the greater part of it has been torn down to use the brick and stone, of which it was composed, as building material.

This aqueduct had ventilators, 1.94 x 1.94 feet in section, and overflow openings at regular intervals. As some of the springs supplying this conduit were very hard, solid deposits of lime (stalactites) were made against the piers where the overflow openings were placed. Where the masonry has all been removed these stalactites are still to be seen at regular intervals. A geologist who did not know about the old aqueduct would be much puzzled to account for these pyramid-like deposits.

The Ponte San Antonio, shown on Plate XI, belongs to one of the later aqueducts and is supposed to have been built by Trajan.

The Aqueduct of Quintilii, shown in Plate XII, supplied a private villa near Rome. It was built of brick and concrete. The many angles made in the line of the aqueduct are illustrated in Plate XII.

Water Supply of Modern Rome.—By the middle of the sixth century, all of the aqueducts had been cut off from Rome, either by the barbarians or by neglect. From this time until 776 A. D. Rome had no water supply except from springs within the city and from the river Tiber. In 776 A. D. the enlightened Pope Adrian I commenced to restore the Trajana, Marcia, Claudia and Virgo. For a short time these aqueducts supplied Rome again with water, but they were soon again neglected. By the end of the fourteenth century, Rome, which


Ségovie. - Perspective de l'Aqueduc

then had about 17 000 inhabitants, had to depend solely on the water found within its limits. In the fifteenth century the popes restored some of the old aqueducts to use. Nicholas V put the Virgo again into service in 1447, but thirty years later it stopped again delivering water. Succeeding popes restored this aqueduct several times, and it has continued to deliver water since the time of Pius IV (1559 A. D.). Its modern name is Acqua Vergine, but since it supplies water to the fountain of Trevi it is, also, known as the Acqua di Trevi. Its discharge is given by Col. Blumenstihl as 1 602 000 U. S. galls. in 24 hours.

The Acqua Falice was built in 1585 to 1587 by the Pope Sixtus V (Felice Peretti) after whom it was named. The springs that supplied the Hadriana, except some which were very hard, and others in the vicinity, were collected in a large reservoir about two miles from Gabii, which was commenced in 1572, but was not completed until 1644. It is still in use, but several smaller auxiliary reservoirs have, also, been constructed.

The original plan was to convey the water to Rome in the old Marcian conduit. After a considerable amount of money had been spent by the first engineer of the works, Matteo da Castello, it was found that owing to some mistake made in leveling the water could not reach the channel of the Marcia. The engineer was discharged. His successor, Giovanni Fontana, built a new aqueduct for part of the distance to Rome. It was located in a much better manner than the old Hadriana, as it crossed the lateral valleys near the dividing ridges. The new aqueduct connected with the channel of the Anio Vetus, which conveyed the water to a point about seven miles from Rome, from where a new conduit was built, following the line of the old Marcia. In many places the new conduit was built on the piers of the old aqueduct, from which much of the necessary building stone was obtained. The work was constructed in two years in a very hasty and clumsy manner, 2 000 to 3 000 laborers being employed. Within the city the water was distributed by leaden pipes, which were laid in some places in some of the old aqueducts.

The Acqua Felice begins near La Colonna (ancient Labicum) and terminates on the Esquiline, its length being fifteen miles, of which seven are carried by arcades. It is still in use.

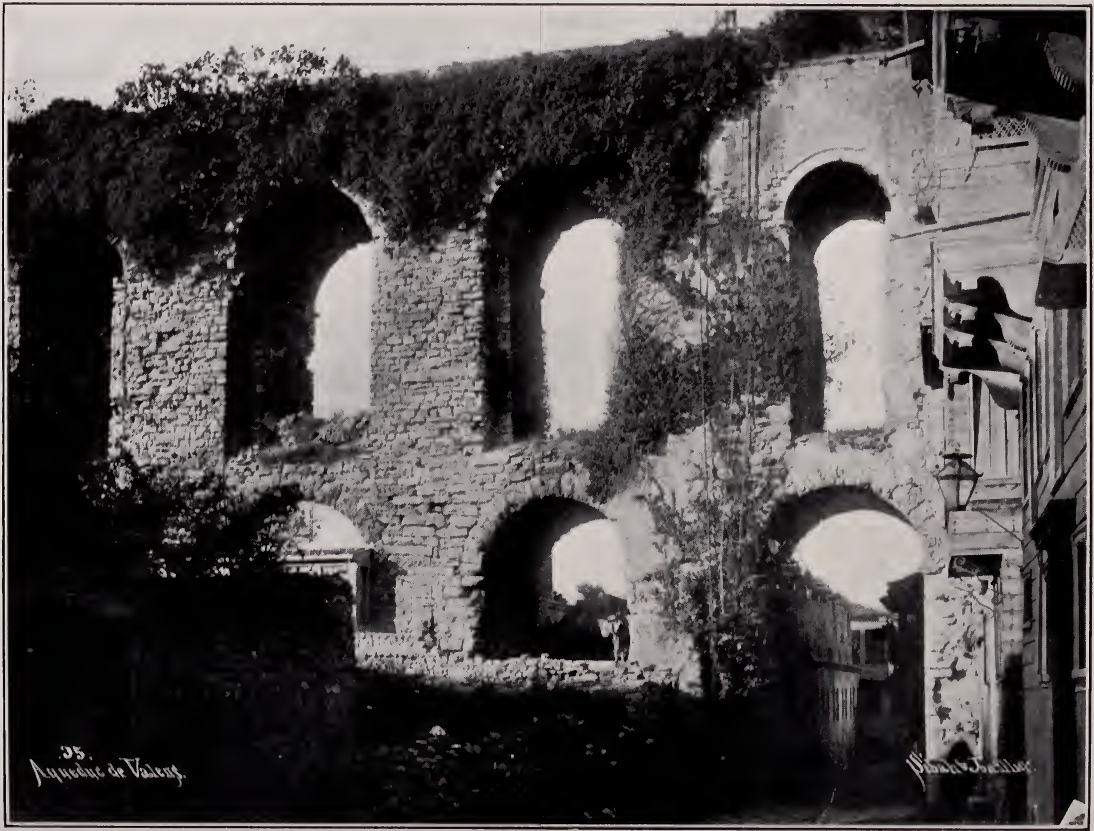
The Acqua Paola.—The Trajana, the tenth aqueduct built for Rome, was about the last of the old conduits to supply the city with water. Its flow was interrupted at intervals during the middle ages, but was repeatedly restored. It was still delivering water in 1561. Pope Paul V restored the Trajana completely, in 1618, building much new work and drawing a larger supply direct from Lake Sabatinus. The water was distributed in the city by different branch conduits and supplied many fountains. The aqueduct is still in use and is called, on account of the last restoration, "Acqua Paola."

The Acqua Pia was constructed in 1860 to 1870 by a private water company to introduce into Rome again the excellent springs which had formed the source of the old Aqua Marcia. The conduit was named after Pope Pius IX, who had taken a lively interest in this work. Col. Bernard Blumenstihl was appointed Chief Engineer of the Company.

It was not known, at that time, which of six copious springs near Agosta was the source of the Marcia. Knowing how careful the old Romans were to select the most wholesome, available water, Col. Blumenstihl followed their method of studying the effect of the water upon those drinking it. The opinion of all people living in the vicinity pointed to the spring known as "Seconda Acqua Serena" (the second clear water) as the best. Col. Blumenstihl had a trench dug across the line on which an aqueduct would naturally be built from this source and found what he felt convinced was the inlet of the old Marcia in perfect condition, only a short distance below the surface of the ground. This spring was, therefore, selected as the source of the new supply.

The Acqua Pía has a length of about 32.6 miles. The difference in level from its source to its terminus in Rome is 778 ft. The average fall is 4.51 in 1 000, which is much more than what is required.

For the first 16.15 miles from the source, the water is conveyed in a masonry conduit whose cross-section varies at different points, its least dimensions being 6.23 ft. height below the key of the arch and 2.62 ft. width. For about half this distance the conduit is underground, and for the remaining part it is carried by five bridges and arcades. From Tivoli to Rome, a distance of 16.47 miles, the aqueduct is formed of an inverted siphon of cast-iron pipes. The plans called for two lines of pipe, but only one was laid at first. The pipes are in lengths of 11.98 ft. and have a diameter of 1.97 ft. The metal is 0.72 in. thick. The maximum head to which the pipes are


35.
Aqueduc de Valens.

subjected is 100 meters. The capacity of the aqueduct with two lines of pipe is about 15 848 000 gals. in 24 hours. The spring which forms the source of this conduit is capable of furnishing 21 000 000 gals. per 24 hours.

The old system of distribution was retained. The water is received in Rome in small reservoirs, from which it is delivered to the consumers by pipes of lead or earthenware.

How much the length of an aqueduct may be shortened by crossing deep valleys by siphon pipes, is seen by comparing the length of the Acqua Pia with that of the Aqua Marcia, which are, respectively, 32.6 and 56.73 miles.

The four aqueducts just described are all that supply Modern Rome. Their lengths, capacity, etc., are given by Mr. Rodolfo Lanciani in his "Ruins and Excavations of Ancient Rome," as follows:

WATER SUPPLY OF MODERN ROME.

Name.	Date.	Author.	Length. in meters.	Volume in 24 hours.in cubic meters.
Acqua Vergine......	1570	Pius V..........................	20.546	155.271
" Felice........	1587	Sixtus V........................	32.593	21.633
" Paola........	1611	Paul V................	51.852	80.870
" Marcia-Pia...	1870	Società dell'Acqua Marcia-Pia.	53,649	121.306

The total supply, according to the above table, is 379 080 cu. m., or 100 130 000 gals. per 24 hours.

Various Roman Aqueducts.—Thus far we have only described the aqueducts built for the city of Rome, but ruins of old Roman conduits are to be found in many other places in Italy, France, Spain and Asia Minor. Wherever the Romans founded a new city, one of their first enterprises was to obtain an abundant supply of wholesome water. Archæologists count about two hundred ruins of such aqueducts. This paper would not be complete without a short description of the most important of these conduits.

The Aqueduct of Minturnæ (Plate XIII), about half-way between Rome and Naples, supplied the ancient city of Minturnæ. It is still to be seen in an almost unbroken line for about two miles. This conduit is a massive structure of concrete faced with reticulated work, alternating black and white, the individual blocks being about 0.26 ft. square.

The Aqueducts of Lyons.—The ancient Roman city of Lugdunum (now Lyons, France), was renowned for the splendor of its palaces, amphitheaters, naumachias, baths, etc. To supply these with water, four grand aqueducts were built during the reigns of Augustus, Tiberius and Claudius. The most famous of these was the Claudian aqueduct, which supplied the palace of the Emperor Claudius, situated in the highest part of the city. It began at Mount Pila (now Mount de Pile) and terminated in a reservoir in Lyons, its length being about 33 miles, in which there was a total fall of about 360 ft. On the line of this conduit there were nine high arcades. One valley 200 ft. deep was crossed by an arcade 2 400 feet long, having five tiers of arches. Another valley 300 feet deep was crossed by an arcade of eight tiers of arches. Three deep valleys were crossed by siphons of oval pipes, made of sheet lead 1 in. thick, the joints being formed with a mastic composition. The pipes were embedded in the sides of the valley or carried by arcade-bridges and were generally surrounded by masonry to give them sufficient strength. The connection between the pipes and the masonry conduit was made by terminating the latter at each side of the valley by a small masonry water-chamber.

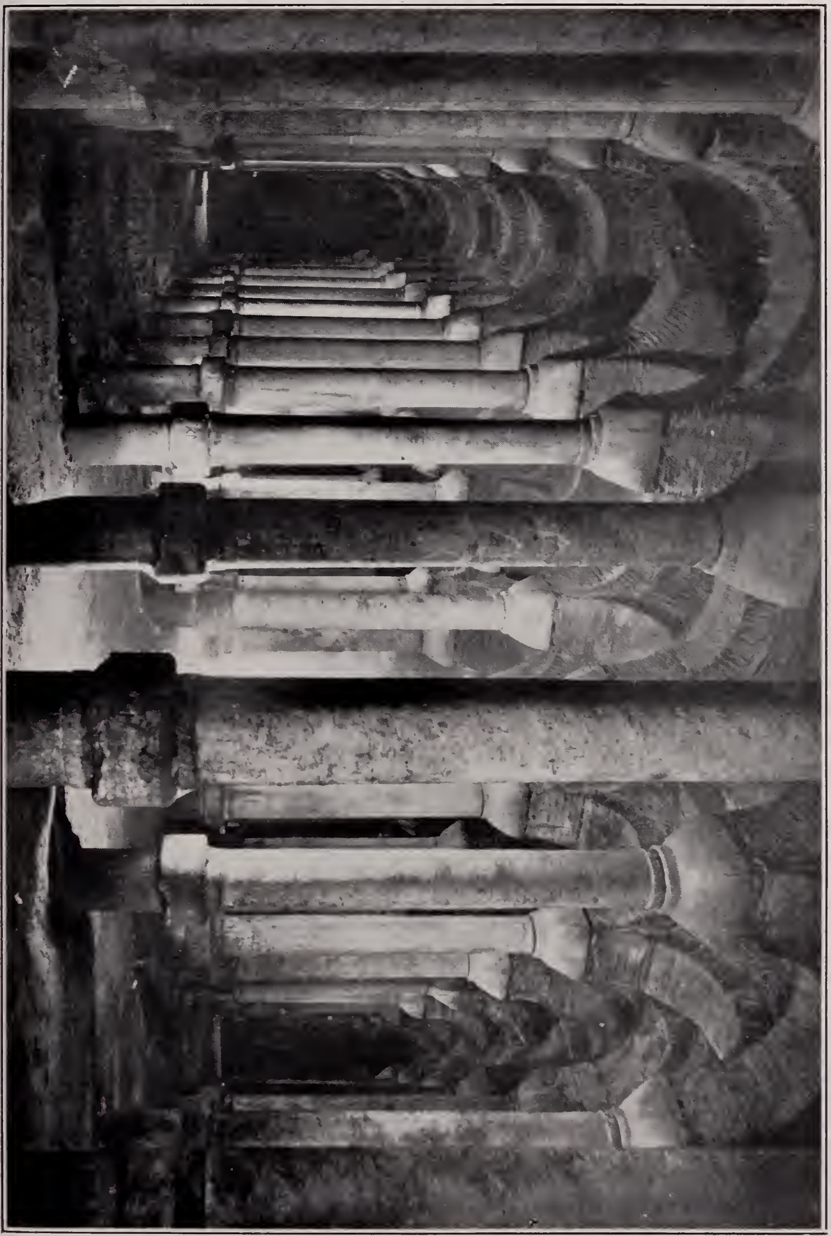
The Garon valley was crossed by nine such oval siphon pipes, about 10 x 12 ins. Across the Baunan valley twelve such siphon pipes were laid.

The Aqueduct of Nismes was one of the earliest and most important aqueducts built by the Romans in France. Its construction is supposed to have been due to Agrippa, the nephew of the Emperor Augustus, who resided in Nemausis (now Nismes) while he governed the Roman colony in that vicinity. This same Agrippa, at a later date, repaired the Appia, Marcia and Alcietina aqueducts and constructed the Aqua Julia for Rome, as stated on page .

The aqueduct of Nismes was nearly 30 miles long and had a general grade of about 3 ft. per mile. Its water channel was generally 4 ft. wide by 5 ft. 4 ins. high, except in tunnels, where the height was increased to 7½ feet. It brought hard spring water to Nismes. From the deposits on the sides of the water-channel it is seen that the ordinary depth of water in the conduit was about 3 ft. 9 ins.

The most remarkable part of this aqueduct is the crossing of the

PLATE XVII.



deep valley of the river Garde or Gardon, about midway between the source and terminus of the conduit. This was effected by an arcade about 160 feet high (Plate XIV), known now as the Pont du Garde. It is still in an excellent state of preservation and is considered one of the boldest pieces of construction of this kind erected by the Romans.

The arcade is composed of three tiers of semi-circular arches. The lowest tier contains six arches. The one across the Garde has a span of 80 ft. 5 ins. On one side of this arch are three of 63 ft. span; on the other there are two arches of 51 ft. span.

The second tier contains eleven arches, all of 51 ft. span. In the third tier are thirty-five arches of 15 ft. 9 ins. span. The piers of the first and second tiers are about 15 ft. wide, measured parallel with the center-line of the arcade. In the top tier their widths vary somewhat, depending on the spans of the lower arches. The width of the arcade at the first, second and third tier is respectively 21, 16 and 10 ft.

The length of the bridge is 562 ft. at the moulding terminating the first tier and 883 ft. at the moulding of the second tier. At both ends of the third tier some of the arches have been destroyed. The height of the arcade is about 160 ft.

The Pont du Garde is built entirely of large cut stones laid without mortar with the exception of the conduit on top, which is formed of rubble masonry and is covered with large slabs of cut stone. The inside of the conduit is covered with a plastering, 2 ins. thick, composed of quicklime, sand and crushed brick (almost pulverized). In addition to this coating, a second thin coat of a fine mastic of a dark-red color was applied.

The top tier of arches was destroyed at both ends in 406 A. D. by the barbarians who were besieging Nismes, and who wished to cut off its water-supply. In the beginning of the eighteenth century the Duke of Rohan cut through the piers of the second tier to make a passage for his artillery. The grand arcade was gradually falling to pieces, but the French government, fortunately, restored it to the state in which it was prior to the damage done by the Duke of Rohan.

The Aqueduct of Segovia, constructed probably in the time of Trajan, is still supplying the city of Segovia, in southern Spain, with water. The arcade shown in Plate XV, which is in the city, is 2 400 ft. long and has a maximum height of 102 ft. It contains 159 semi-circular arches. Those of the lower tier have spans of 17 ft., while in the upper tier the spans vary from 14 to 15 ft. The structure consists of large blocks of granite laid dry, mortar being only used in the lining of the water channel.

The Aqueduct of Valens was built in 368 A. D. to supply Byzantium (Constantinople) with water. Plate XVI shows part of an arcade of this conduit in the city. Its greatest height is 74.5 ft. Other conduits were constructed at later periods (such as the aqueduct of Justinian II, built 576 A. D., etc.).

In connection with the water-works of ancient Constantinople a system of underground reservoirs or cisterns was constructed, which, at one time, was said to have stored enough water to supply 1 000 000 people for four months, in case of a siege. Many of these cisterns are still to be seen and are in good order.

The most famous of these subterranean reservoirs, known as the "Cistern of 1001 Columns" from the many columns it contains, is shown on Plate XVII.

Authorities.—In conclusion we will give a list of the principal books that have been written on the Roman aqueducts.

Raphael Fabretti, De aquis et aquæductibus veteris Romæ, 2d Ed. Rome, 1788.

Alberto Cassio, Corso delle acque antiche. Rome, 1757–59.

Carlo Fea, Storia delle acque di Roma.

M. Belgrand, Les Aqueducs Romains. Paris, 1875.

John Henry Parker, The Aqueducts of Ancient Rome. Oxford, England, 1876.

Rodolfo Lanciani, I comentarii di Frontino intorno le acque e gli acquedotti. Rome, 1880.

Alessandro Bettochi, Le acque e gli acquedotti di Roma antica e moderna (Monografia della città di Roma, Vol. II, Ch. XIX, 1881).

Clemens Herschel, Frontinus and the Water Supply of the City of Rome. Boston, 1899.

Curt Merckel, Die Ingenieur Technic im Alterthum. Berlin, 1899.

DISCUSSION.

Mr. Wait.—It requires courage to get up and say much after the introduction given us. Engineer Brown, of the Sewer Department of Manhattan, was in the office the other day and interested me in a book printed in 1842 here in New York by an ex-Commissioner of Patents, Thomas Ewbank, which I found a very interesting book. The remarks made call to my mind what has been said about siphons. Recent discoveries in Egypt show that siphons were in use in Egypt in 1450 B. C. and that they were, not only of pottery, but also of metal. It is said that Archimedes used lead pipes in his men-of-war, and in the ship *Hiero*, which he built, which was lined or the bottom was covered with sheet lead. It is also stated that the houses in Athens had lead pipes which conducted the water throughout the buildings.

In connection with the lines or breaks in the lines of the aqueduct, it has occurred to me, from the diagrams shown, that they changed their line of direction and followed the stream, and I wondered if the foundations might not have had something to do with the changing of the line of the aqueducts. All these systems of water works in the early times were gravity systems, and it was not until about 1600 that pumping machinery for the purpose came into use, and not until about 1700 that systems of pumping were in use on a large scale. The early systems of water-works described by the speaker this evening have been confined entirely to those of Rome, or at least practically so, but Cortez, in his conquest in Mexico, about 1519, found there excellent systems of water-works, extending for many miles to the mountains, all underground, and made of earthen pipes and so buried as not to enable the Spaniards to follow them or to determine from whence they came; and this same system of water-works carried the water into and throughout the houses the same as our own systems.

It has occurred to me that these breaks and repairs which have been pointed out were caused by earthquakes, which were so prevalent at about this time, from about 50 to 250 A. D. I think some of the things the gentlemen has spoken of to-night might be explained in that way. Speaking of these rulers and also of the contractors who took pride |in building water-works systems reminds one of the ancient who redeemed himself from his sins by digging a well, and therefore it is supposed that the Romans did like things to perpetuate their memory. I would recommend the reading of this book mentioned by Ewbank, from which I derived a great deal of pleasure.

Mr. Brush.—I do not know as I can say very much about Roman aqueducts. Nor is there very much to say about our system of aqueducts here in connection with the Roman aqueducts. I might give a little description of a section of one of our distribution pipes that we cut the other day. It showed that we need to replace some of our mains in the near future.

It was a section of a pipe laid about 1858 and was uncoated when laid, and was found to be very badly tuberculated. The 30-in. pipe was about 1 in. in thickness, and under the tuberculations the iron was softened to a depth varying from about $\frac{1}{8}$ to $\frac{1}{4}$ in. The iron could be quite readily cut, and I was rather interested in what Mr. Jackson, our chemist, was saying to-night about the formation of the tuberculation and also the iron underneath. I don't know if Mr. Jackson is prepared to state anything about it, but perhaps he will tell us something in regard to it. I am not very familiar with the formation of the tuberculation on pipe, but I do not think the Romans were troubled very much with incrustation in their pipes. I presume, when uncovered, they were quite clean, were they not?

The Author.—They were clean.

Mr. Jackson.—The tuberculation of iron water-pipes in Brooklyn is a subject somewhat removed from a discussion of the Roman aqueducts, but since it is called for I will describe the results of some examinations made recently at Mt. Prospect Laboratory.

In old water-pipes, and sometimes in pipes which are not very old, there is often a heavy deposit of oxide of iron or iron rust. Instead of being of equal thickness around the inner circumference of the pipe, as would be expected, we usually find that the pipe fills up in places in a very uneven manner, and that finger-line projections are very numerous.

So far as I am aware, the cause of this peculiar, but common, formation in water-pipes has not previously been explained. It has at times been attributed to an iron-carrying organic growth of some kind, but I have made numerous microscopical examinations over a long period of time to discover such a growth and have always been unsuccessful.

This week, in making one more attempt to solve the mystery, I examined the pipes which Mr. Brush has described and found, as usual, no organic growth. The pipes were about twenty-five years old and the tubercles were particularly fine, large specimens and so hard that I was able to cut sections of them and make a thorough microscopical and physical examination. The finger-like projections were composed of separate layers or accretions, one above the other, and the lower layers were evidently a much older formation than the upper layers. This, together with the physical structure, proved conclusively that tubercles are merely forms of what are known in mineralogy as botryoidal or stalactitic crystals. These tubercles are formed just as crystals are formed in a concentrated liquid, and take as nuclei the rough or uncoated points on the pipe. When once started they serve as a depositing area for successive accretions until the crystal is built up. The rapidity of growth depends upon the amount of iron in solution in the water and the amount of oxidation and consequent precipitation of this iron which takes place. It was noted that the lower portion of these crystals often had the composition of Fe_2O_3, but usually the entire crystal was composed of $2\ Fe_2\ O_3\ 3\ H_2O$. In mineralogical formations in the earth we have the exact counterpart of these crystals both physically and chemically in the botryoidal crystals of hematite and limonite.

Mr. Carr.—There were a number of old wooden water-pipes dug up in connection with work under my charge in the lower part of New York, most of them in connection with the work of the Metropolitan Street Railway, but some during the prosecution of the Rapid Transit work. I do not recall the exact dimensions of these pipes, but think they were all of about the same dimensions, being about 8 ft. long and of different internal diameters. The largest that I recall had an internal diameter of 4 ins., and the smallest was 2 ins.

All were hub and spigot pipes and made of spruce or cedar logs. The hubs were made by a tapering counter bore at one end, and the spigots were made by turning down the other end of the log so as to fit in this counter bore. The hub ends were reinforced by a band of iron, which was wedge-shape in cross-section, and about an inch less in diameter than the diameter of the wooden pipe. This band was driven into the hub end of the pipe, being about ½ in. inside of the external circumference of the pipe.

The gates were quite an interesting feature of this old pipe-work. They were formed simply by a piece of iron like a spade driven into a transverse cut sawed in one side of the log. The water was evidently shut off by driving this spade-like piece of iron down, and an "eye" was forged in the top of the piece for the purpose of giving a hold for pulling out or raising the gate.

Another interesting feature was the taps, of which I have only seen three or four. They were made, I think, of iron, though I am not positive on this point. They were shaped like a corporation tap, that is, being tapered to drive into a hole in the log, in the same way that the present corporation tap is driven into the iron pipe. The branch was on the side of the tapered body of the tap, the same as the present corporation tap, and the cut-off was formed by driving a wooden plug into the top.

Mr. Nichols.—As stated by Mr. Wait, the Egyptians probably used a vitrified pipe, or something equivalent thereto, for their water supply. Throughout the earlier settlement of this Continent, the Spaniards came over here with lessons learned from the Romans, and in Mexico and in some places in South America there are fair samples of aqueducts of the Roman type. There is one near Vera Cruz, in Mexico, and in the City of Lima, Peru, there is a large portal or city gate, something similar to one shown by Mr. Wegmann, which was evidently used in part for ornamental purposes, standing 100 or more feet in height and perhaps 200 ft. in length, and which formed a monumental terminus to an aqueduct. The stone then used by the Spaniards, and to a certain extent now by the modern Peruvians, is very largely volcanic origin, so soft that it may be cut with a hand axe or hatchet. It is, however, quite durable, and strong for ordinary masonry construction. Lima was founded about 1535, and probably the piece of masonry above referred to dates back nearly to that time. I don't remember the name of the Viceroy in whose honor or by whose munificence this aqueduct and fountain was built, but it was used as a fountain, various openings being found in the face of it from which water was allowed to spurt. The water was brought to it in an acéquia, or open canal. Of course, in that climate, where there is never any frost, and rarely ever rain, and a great deal of heat and sunshine, a soft stone would be more durable. The question of enclosing aqueducts in the ground or in pipes was not so important. I imagine that the people were not so cleanly as the Romans, and perhaps did not require so many baths, and most of their water supply was required for purposes of irrigation. The largest use for water in Peru was for irrigation purposes. Over the whole area of Peru, extending 1 000 miles up and down the Pacific Coast, and inland, perhaps, 100 miles, the rainfall will not average more than 20 to 30 ins. in the year —not enough to sustain vegetation. The result is that all vegetation is nourished by irrigation, and this was carried on, particularly before the advent of the Spaniards, on a very extensive scale. One is impressed with the work accomplished, more with the magnitude than the excellence of the masonry and the like, but certainly impressed with the magnitude of the works. The people must have been either very numerous, or very industrious, and I imagine both. They were a peaceful, law-abiding people, and a generous people, and to this I have always ascribed the fact that the Spaniards, with their brutality (then as now), overcame them so easily. They were afraid of the man on horseback, instead of admiring him, as they do to-day. The country was hilly. There was a great deal of it, but it was mostly on edge. There are ranges of hills or mountains in Peru with slopes extending back from the valleys for thousands of feet and extending in elevation for other thousands. The highest slopes, in many cases 2 000 ft. high, are terraced from the bottom to the top with dry stone walls, generally of rough rubble laid dry, and these walls are often 6 and 8 ft. high, and the horizontal bench terraces corresponding to them are not more than 10, 15 or 20 ft. wide, but they will extend nearly horizontally sometimes for half a mile or a mile around the slopes of a hill and up into the valleys, walls and terraces in that way. The height to which the cultivation on these slopes could be carried depended entirely on the relation of the upper elevation to the source of water supply, and they would run back into the valleys for miles, tap the mountain streams—generally a stream fed by melted snow—and bring it in the open acequias or canals. These irrigation canals are rarely ever more than 2 to 3 ft. wide at the top, just excavated out of the rock and earth, with the ordinary slopes, and carried around, conforming to the contour of the hill, to the upper elevation of the terraces. The water gradually trickled down from one level to another, until the whole extent of this vast area, as previously indicated, was furnished with water.

A small mud dam stops the water from running in one place and diverts it to another, and so these numerous and industrious people irrigated these garden farms of theirs as they do in the mountain regions now, and raising, considering all the circumstances, great crops. They raised more corn than anything else, and chiefly corn and potatoes. The potato is indigenous or native to Peru. The Incas, whom the Spaniards found in Peru, and who were the ruling race there at the time of the Spanish Conquest, were a race superior in intelligence to the people who preceded them. Prescott states that the Incas had a custom of taking their own people, brought up in their civilization, and distributing them among the people whom they conquered; that is, when a band or tribe was subjugated they would immediately transfer one-half of that tribe to the mountain region, placing them right among their own people and then transfer an equal number of their own people to the new settlement. The effect of this system was to bring the conquered people at once up to their standard of civilization.

Near the present town of Chimbote, about 200 miles north of Callao, in Peru, there is an extensive plain along the coast and extending inland and now covered with sand blown and drifted into place; this sand covers the site of an ancient settlement, probably antedating the Inca civilization. The pottery and remains found there indicate that this ancient settlement was composed of people intelligent, but semi-barbaric, and still agricultural in its pursuits. The area includes some 50 000 acres and no doubt supported a large population. It almost never rains in this locality, and the water was furnished to the district by a canal or acéquia about 10 miles long, having its source of supply at the Santa River, about 15 miles from its mouth. The canal is still in existence, with banks and slopes generally almost as perfect as when built. An attempt was made in 1873 to redevelop this area, to dig out and restore the canal and let the water of the Santa run through it again. A similar district adjacent to it was redeveloped about this time, and a hacienda of some 25 000 acres was restored for the growth of sugar cane. This hacienda had about 30 miles of railway track laid over it when I visited it in 1875, and had an extensive sugar-grinding and refining plant on it, which was fed by this railway from the cane fields of the hacienda. For the Chimbote project the old canal was dug out and restored for nearly its entire length. This canal was about 10 ft. across at the top and had a depth of 3 to 4 ft., with inside slopes of about 1 to 1, carefully graded and puddled. The grade of this canal was comparatively low—much lower, I think, than that which Mr. Wegmann gives for the Roman canals, and probably not more than 2 ft. to the mile. The method of leveling must have been even more crude than that of the Romans; the Peruvians probably felt their way along and determined experimentally the grade at which the water would flow. At a point 6 or 8 miles from the ocean the Chimbote Canal was carried across a deep ravine, now called the Rio Seco, or Dry River, because no one living has ever seen water running in its bed. This ravine was nearly 1 000 ft. broad at the grade line of the canal, which was upward of 60 ft. above the bed of the ravine. The restored canal was finally carried over the ravine in a wooden trunk on a timber trestle.

The ancient Peruvians had carried their canal over this ravine on an earth bank, and in order to build this bank they had denuded the rock for miles around of all earth, gravel and loose material. When one day a flood did occur in this ravine, it carried out their bank and may, indeed, have driven the ancient residents of Chimbote out of their homes for want of water. They seem, at least, never to have attempted to rebuild the bank or restore the canal, simply for want of material for another bank. The Peruvians of that time were not as fully developed, structurally speaking, as the ancient Egyptians, and masonry construction was out of the question for them as it was from an economical standpoint to the engineers who built the timber trestle in 1873. The old canal, with its puddled slopes and its evidence of a huge earth bank to carry it over the Rio Seco, stands as a monument to the skill and industry of its builders, who doubtless worked at it at least as early as Frontinus labored with greater skill for Rome.

It seems very singular, thinking over Mr. Carr's remarks and remembering that I have seen, from time to time, a great many sections of this old wooden pipe dug up which was laid by the Manhattan Company, that within 100 years pipe of that construction should have been used in New York City. Just before the American Revolution Parliament passed an act making it absolutely illegal to manufacture cast or wrought iron within the Colonies, and this was done boldly and avowedly for the purpose of protecting the iron industry in the mother country. Later, of course, iron made in the mother country was expensive to use here, and we were a poor people, and after the revolution, no doubt, the spirit of patriotism carried us so far that we would not use an English pipe if we could, and I suppose these were largely the reasons why this wooden pipe was so extensively used in New York City early in the 19th century.

Mr. Wait.—In connection with Mr. Nichols' remarks, I could add that I myself have seen logs bored out and laid in villages right in this State, and that was in my own day and recollection, which is not very long.

Mr. Tuttle.—I do not know that I have anything to say which would add materially to the value of the excellent paper that we have had this evening. I could not help but think, however, as we were looking at some of the pictures, that very possibly we are working around in a circle after all. We note that the ancient method of storing water was in underground galleries, and the probabilities seem to be that, as filtration is adopted in these days, we must resort to covered reservoirs, and, perhaps, here in New York before many years have gone by. In looking at the pictures of these old aqueducts as they exist to-day and are in use, I suppose we wondered whether the structures that we are putting up to-day would have a similar length of life, and that we were all inclined to be skeptical concerning the probabilities. It may not be entirely fair to compare modern structures entirely dependent on cement for their durability with the massive Roman structures, yet these old structures, where they were rebuilt, showed that the cement used performed its work well.

The brick and stone masonry of the original Brooklyn Water Works, built in about 1860, was laid in natural cement, which was then the only kind in use. Recent examination of the conduit shows that the construction is as sound as if newly built, and on one occasion, when cutting through a massive rubble foundation wall, I found that fracture often occurred in the stone instead of at the joint. In 1889 Brooklyn extended its old aqueduct eastward about 7 miles. The cement specified for that work was natural cement of ordinary quality—good quality at that time, but I suppose to-day we should class it as an inferior grade of cement. In one section the contractor was ready and signified his desire to begin work before the cement had been tested, as he was very sure of his cement. The consent of the engineer was obtained on condition that if the cement failed to meet the requirements, the work should be taken out and satisfactorily replaced. The contractor went ahead and the cement tests were begun, but after 28 days it was found to be very much below requirements, and an examination of the work showed that where the brick had been laid about three or four weeks, one could take a nail and push it right through the joint. The contractor was ordered to take down the work, but he failed to heed the order until the final day of reckoning came in the way of a final estimate, which was refused on the ground that he had not replaced this section with good work. After argument, he finally started to take down and rebuild this section, and in breaking it out we were surprised to find that the masonry would very frequently part in the brick instead of at a cement joint; in other words, this slow-setting natural cement, which had entirely failed to to meet what were considered as most reasonable requirements, was equal if not superior, to any cement used for that work. I cannot help but wonder if we are not going to too much of an extreme in the testing requirements of our cement to-day and forcing immediate high tensile strength at the expense of its quality after the lapse of years.

Mr. Wagner.—In regard to the covered reservoirs, most of this work was done by the soldiers in Rome, and not only the construction of the streets, but also these aqueducts. Mr. Wegmann referred to certain legions. I think it is in the history of the Roman Republic that you will find reference made to these legions. They found that these legions in times of peace were rather a nuisance, and to keep down rebellions and riots they used to use them for all sorts of work, and a great many of these aqueducts and other structures were built for this reason. Furthermore, as far as deploring the loss of the use of stone without cement, if you go to Italy or France at the present time you will find stonework even more perfect than in those ages. You will find in the neighborhood of Turin a bridge with a single arch span of about 150 meters, composed entirely of stone blocks fitted together without the use of cement. Some blocks are in the neighborhood of 12 ft. high. In France during the last 100 or 150 years they have been building these large arch structures. As regards the covered reservoirs, the Romans covered them simply for military purposes; they were storage places in time of war and their design was for this purpose, with no idea of preserving the purity of the water; it was simply a military precaution.

Speaking of the admirable stone masonry, I think, Mr. Nichols, that in the land of the Incas you found some admirable specimens, especially in their bridge and highway construction, did you not?

Mr. Nichols.—Not so much in the bridge construction. They built very few bridges of great length, although they have the credit of being among the earliest suspension bridge builders. As to the stone, I think we are apt to give them too much credit for very careful stone laying, according to our modern standard. The most of the stone that is laid is in block, and some fine specimens of it antedate that laid by the ancient Peruvian. There is a good deal that has withstood earthquakes, but fine cut stone and block stone, what we call ashlar, nearly all that is of the softer grades of stone which I previously referred to. Where they have some frost and a little snow and a good deal of cold weather, though not much freezing weather, in those localities they have built with the harder stone and built walls generally of this stone, and in some cases very expensive walls, and these walls have been described truly by Mr. Wegmann as being laid with joints into which you could not insert the blade of a knife. This is true. Most of flat stone-work was built like our brownstone fronts are built, dry and laid in the slopes on edge and built with a bond so that they would not fall out. The stones were taken and fitted together. Time seemed to be no object to them, and the method generally pursued seemed to be to place a couple of stones in position and dress the two stones so that they came together nicely and then dress the top edges, not to a horizontal level surface, but to any surface that happened to be most convenient with the stone, making, say, of these two stones a triangle and perhaps inclined 30° or 45° and having another stone of that dimension and fitting it in there so that the joints came very close together only at the outside; at the back they were not so good. They built for looks and not with regard to horizontal or vertical joints.

THE MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK.

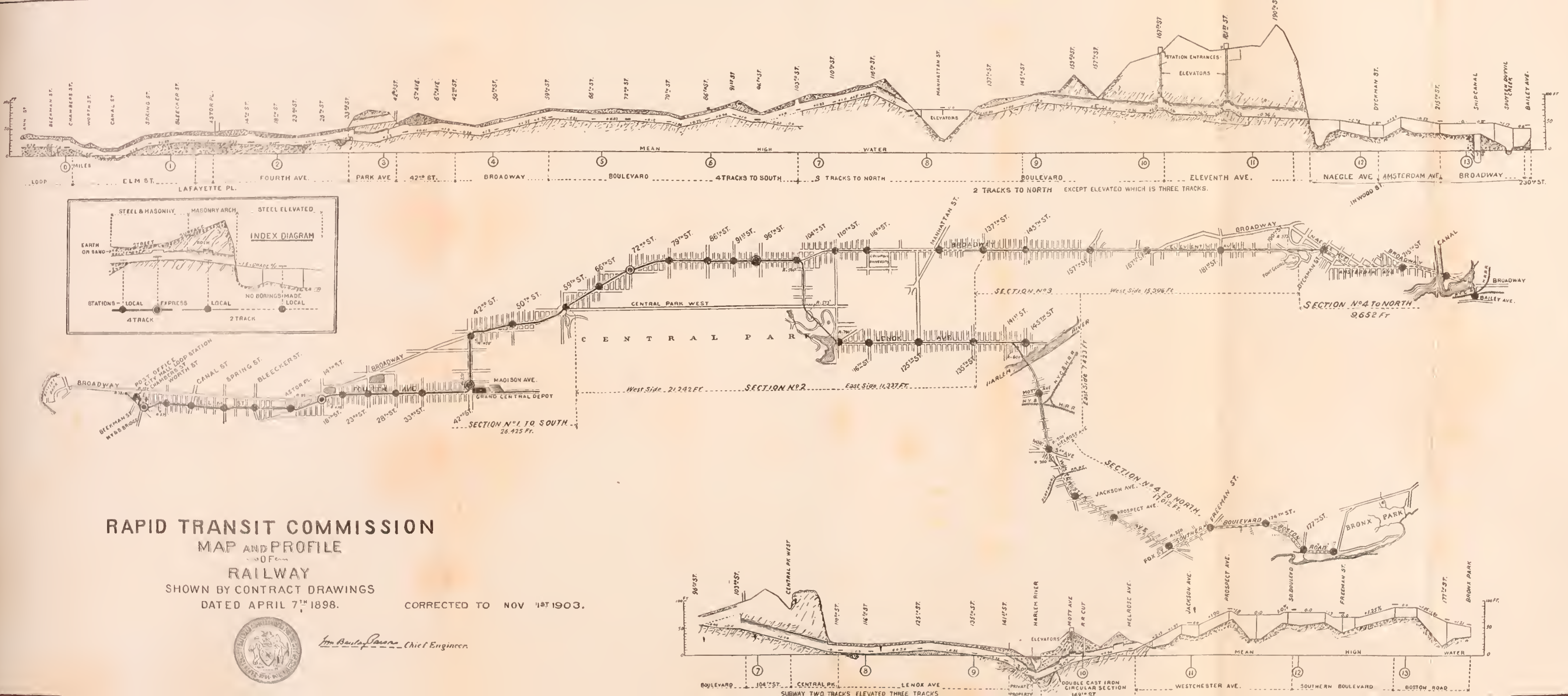
Paper No. 3.

RAPID TRANSIT IN NEW YORK CITY.

By George S. Rice, Member of the Society.

Presented September 30, 1903.

I am very glad to talk to-night on the question of rapid transit. I realize that it is a large subject and will not go into great detail. I am going to treat it in a general way, commencing with the first demand, in 1831, for improved facilities for New York City, when it was sought to get a surface railroad down Broadway, and in 1833 this was virtually accomplished by having the double track line down Fourth Avenue to City Hall. The street railways took care of the people in a general way, and in 1869, when the first elevated line was built, ran a short line (a cable line) down Greenwich Street. When, however, the legislature passed an act in 1875 organizing a Committee which looked into the question of elevated roads, and which afterwards became the Manhattan Elevated, the public were to a great extent relieved. The Street Railway people, always alert, went to the legislature at that time and had an act passed that no road should be built which could pass over, under or through 42d Street, creating the condition of having a disjointed road, *i. e.*, separating the city north of 42d Street; and in after years, from 1880 to 1890, when several Commissions were appointed for the furtherance of rapid transit, this difficulty invariably confronted them. Fortunately, in 1891, an act was passed by the legislature annulling that restriction, but when the matter came before the public, or rather, came to a test, there was no responsible bidder.



RAPID TRANSIT COMMISSION

MAP AND PROFILE
OF
RAILWAY

SHOWN BY CONTRACT DRAWINGS
DATED APRIL 7TH 1898. CORRECTED TO NOV 1ST 1903.

Wm Barclay Parsons Chief Engineer.

(1409) 16 ST. 4th AVE. 11-12-1901

Of course, that means a complete reconstruction of sewers and relaying of water pipes throughout the entire route.

In the original discussion or study of rapid transit, the first question that came up was how the road should be built, whether a deep tunnel would be more advantageous, or to build close to the surface of the street. It was decided that a shallow tunnel would be the better type, leaving a subway where it is possible and more convenient, and then a deep tunnel when necessary. As laid out to-day, taking the three miles in Brooklyn which has been added to the 21 miles of the McDonald contract, there are 24 miles of railway (about 80 miles of track actually, but 24 miles of railway). Of that, 13½ miles are subway, 5½ are elevated and about 5 miles are deep tunnels; so that we have all methods of construction in New York City.

In the construction of the subway in New York City an immense amount of rock has been excavated. Of over 3¼ million cubic yards of excavation in the McDonald contract, nearly one-half is rock. When it is attempted to take the rock out of a crowded city like New York, with the tracks of surface railway, it is a very serious problem. In that portion of the work where we expected the least trouble, we had the most, *i. e.*, Major Shaler's contract, between 41st and 34th Streets. Here there seemed to be a concentration of bad results, and although the damage was not very much from a monetary standpoint, there was loss of life. It is well known how Major Shaler met his death. It was a sad affliction and an unfortunate ending of a brilliant life.

As to the masonry and steel on the work, the detail is something stupendous. There are 62 000 tons of steel which are being made and which are almost in place, and the design of that work is very large. The material has been very carefully inspected, much more so, I think, than any work ever constructed, notwithstanding the amount of work. The inspection of the work has been done very carefully. All steel is tested. Even the shop work is looked after with a large corps of Inspectors, who are appointed under Civil Service rules, and the cement is inspected. The paint and the asphalting, and in fact all material of the rapid transit work is carefully inspected. I want to speak more particularly in reference to the cement, which has been well under control. It is the best cement used in this country, mainly because it has been uniform. The Engineers have been somewhat arbitrary with the manufacturers, have gone right into their works,

PLATE III.

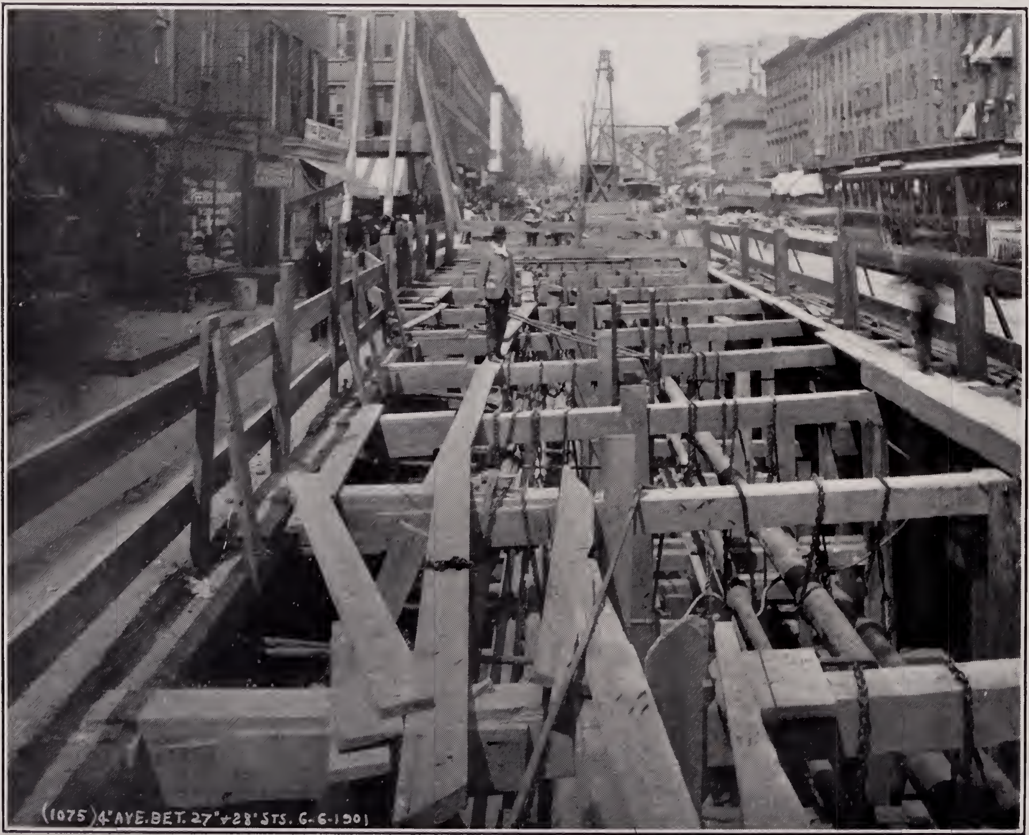
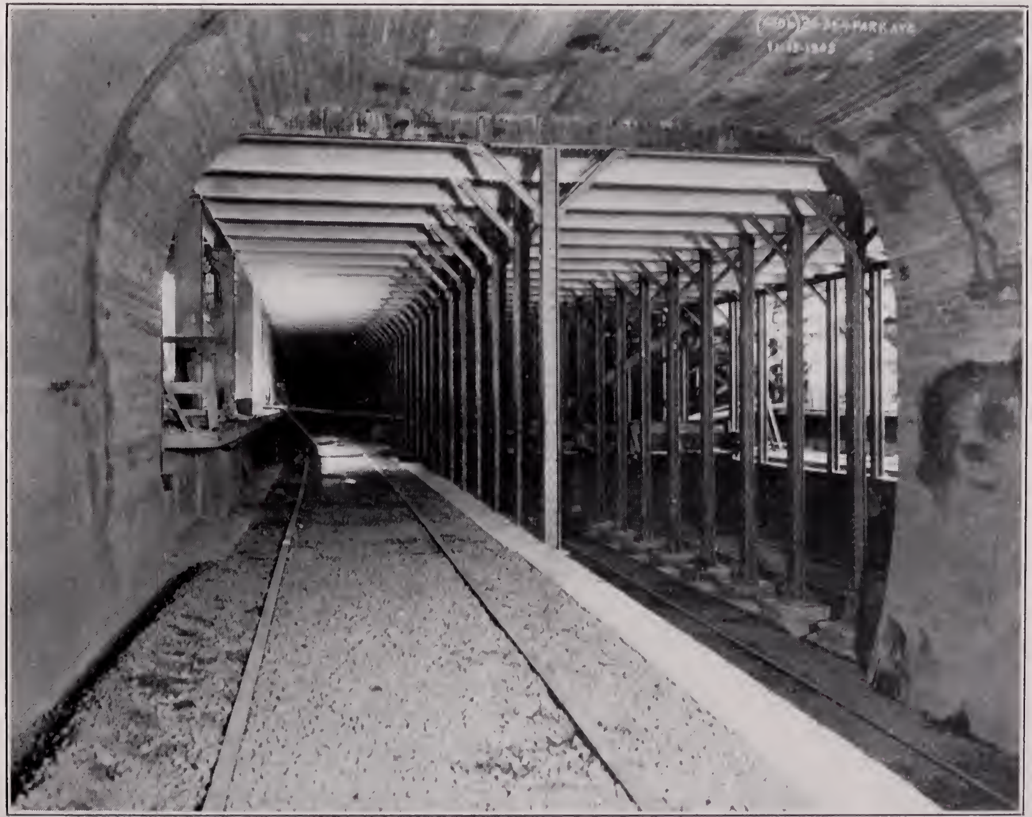


PLATE IV.



and have tested the material as it goes into the bins, when it is tagged, so that one can go on any portion of the work and find evidence of when the material was tested, and the records will show just exactly what the conditions are in which it was accepted.

The principal elements of design, have been speed and watertight work. To have the subway watertight, the principle involved is that if you exclude the dampness, you will in that way have an air which can be handled. Instead of being a heavy air you will have an air something like the atmosphere of this room, and that principle has been the one evolved when the design of the New York subway was made. What the results will be will be demonstrated in the next year. In many portions of the work we have some leaks, which we are trying to remedy, but as a general thing the work is watertight and the air of the subway is good.

As to the question of speed, the problem was to take all classes of travel from one end of the city to the other, *i. e.*, from Kingsbridge and The Bronx to the City Hall. Of course this is a complicated question and the way to solve it is to have a four-track line from City Hall to 104th Street which would allow of an express service for that distance; then on the west side of the city up to 147th Street extend the four-track line to a three-track line, allowing an express service morning and night during the rush hours or whenever required; and for the east side, in the same way, to have two and in some places three tracks. When the Commission laid out the original route it was intended to have an east side line, but as the Court decreed that the expenditure must be cut down below $50 000 000, the Commission reduced it to about $35 000 000. That really threw out the east side line, but in laying out this route that was not overlooked and the scheme contemplates making extensions in different directions which I will speak of later.

The express line has stations 1½ miles apart, that is, starting at the City Hall, one at 14th Street, the next at 42d Street, the next at 72d Street, and the next at 96th Street. In that way one will be able to start at City Hall, and, with the schedule as already laid out by the operating company, get to Harlem in fifteen minutes, and reach the different parks on the east and west side of the city in thirty minutes.

The express tracks will accommodate trains with eight cars or less,

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The express tracks will accommodate trains with eight cars or less, and on the local tracks there will probably be five-car trains or less.

The number of miles of sewer construction was about 12. This matter was gone into very carefully. The details was published in the contract plans, and were very carefully considered. There were over forty miles of water pipes, gas pipes and electric ducts, etc., which had to be reconstructed and moved, and to date, covering a period of three years and seven months there has been expended of the $35 000 000, not including extras, about $29 000 000. The contract time is 4½ years, and the time is not up until about September, 1904. Had it not been for the strike last summer, the road would have been in operation in the latter part of October or the first part of November. At the end of next month there will only be two portions of the work where excavation is not completed. Those two places are Fort George, where there is about 600 lin. ft. of tunnel to be excavated, and under the Harlem River, where there is a section of about 300 ft. of tunnel to be constructed. Half of this tunnel has already been constructed, and the other part is to be constructed within the next year.

The material encountered below 14th Street is mostly sand and gravel, but which is generally dry, free from moisture, except where it comes under Canal Street and vicinity, and in the lower part of Broadway; from 14th Street to 122d Street rock and gravel are encountered; rock also extends to Fort George, and on the Central Park section, to the junction of Lenox Avenue and 110th Street, and in the tunnel through 114th Street to 104th Street, but north of that point gravel and sand are found until you get to this side of the Harlem where there is some limestone.

The original contract contemplated that the stations would have platforms about 200 ft. long, but when the contractor considered the changes which he was asked to make in the design, his first request was that the express stations should be placed nearer together, less than 1½ miles apart. Mr. Parsons, however, insisted on the distance between the express stations as originally proposed, 1½ miles apart, as affording real rapid transit, enabling those living in the outlying districts to get to their homes with few stops. After 96th Street is passed the road is so designed that if desired to have an express service from 96th Street to 168th Street the stations between these two localities can be made express stations, switching facilities hav-

PLATE V.

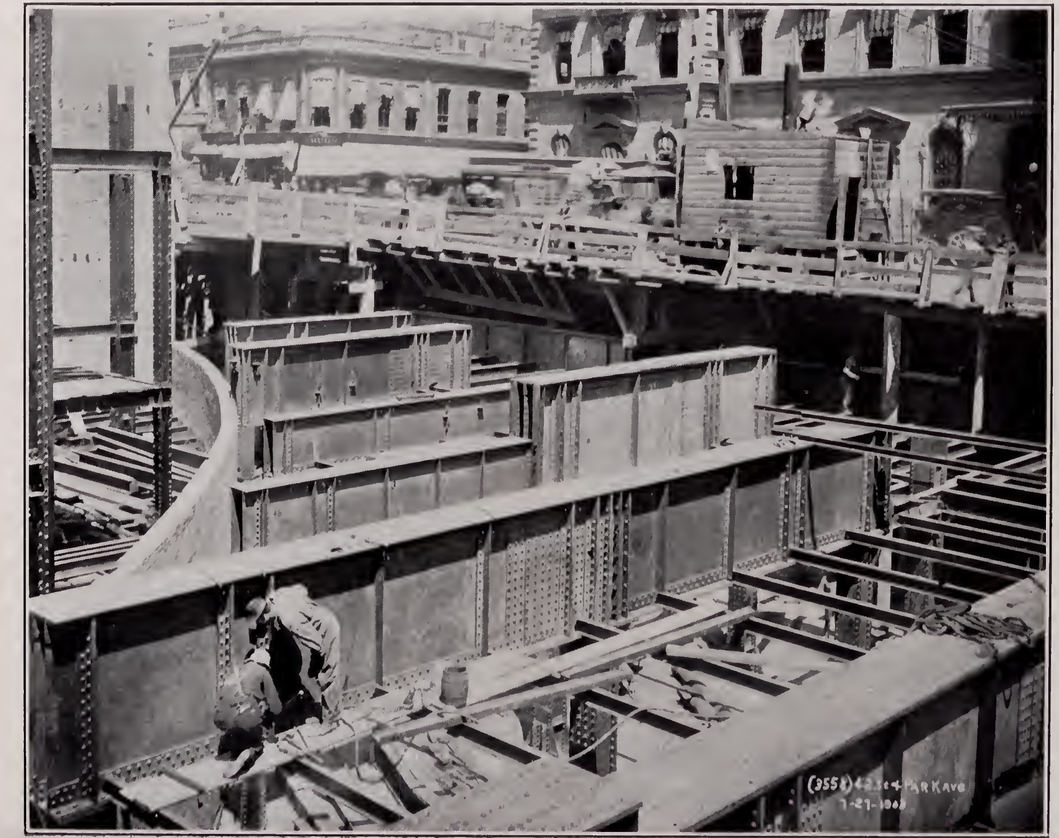


PLATE VI.

ing been provided to accomplish this purpose. There are sidings arranged at 42d Street and at different places along the line of the road. At 42d Street there is additional track so a train can be run in there instead of running all the way downtown, and a schedule could be made to accommodate the travel. There is also another fifth track at 14th Street arranged for the same purpose; another at Spring Street, and also two loops, one at City Hall, which is a single track loop, and which enables the trains, instead of going down to the Battery to be turned around and sent uptown again from that point, and a double loop at the Battery, so that the operation of the road can be made to meet the demands of the traveling public.

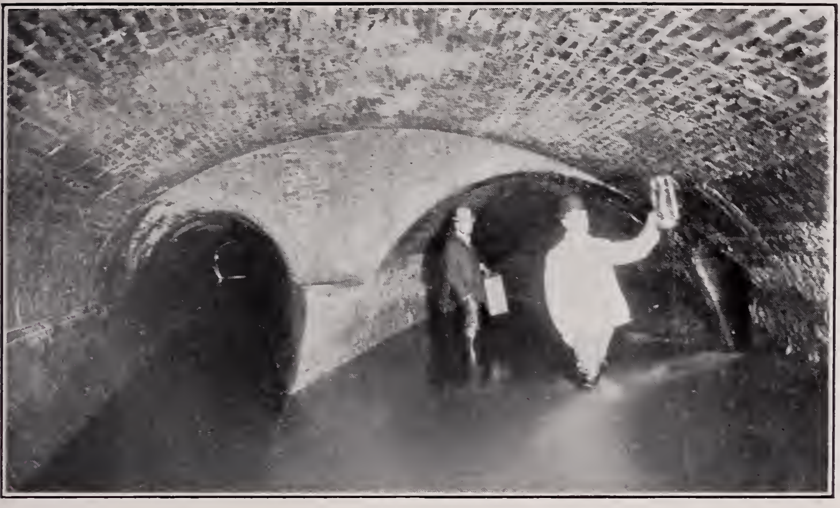
On Broadway between 137th Street and 142d Street there are eight tracks under ground, five of which are for the storage of cars. Instead of having the ordinary storage as you have seen on the elevated road at 145th Street, these tracks have been put underground and placed so that they can make up their trains with the least amount of trouble and which can be operated with ease. On the east side there are terminals at Lenox Avenue and 150th Street, another at 177th Street and Southern Boulevard which will afford facilities for the storage of cars, etc.

When it is considered that in building this railroad the contractor is using 1½ tons or 2 tons of dynamite a day, the difficulties under which the contractors have done their work are apparent; and with the blasting that has been done at all hours of the day and night on some portions of the work, the wonder is that more accidents have not occurred. The only real serious accidents have been the slipping of rocks in tunnels and the explosion at Park Avenue.

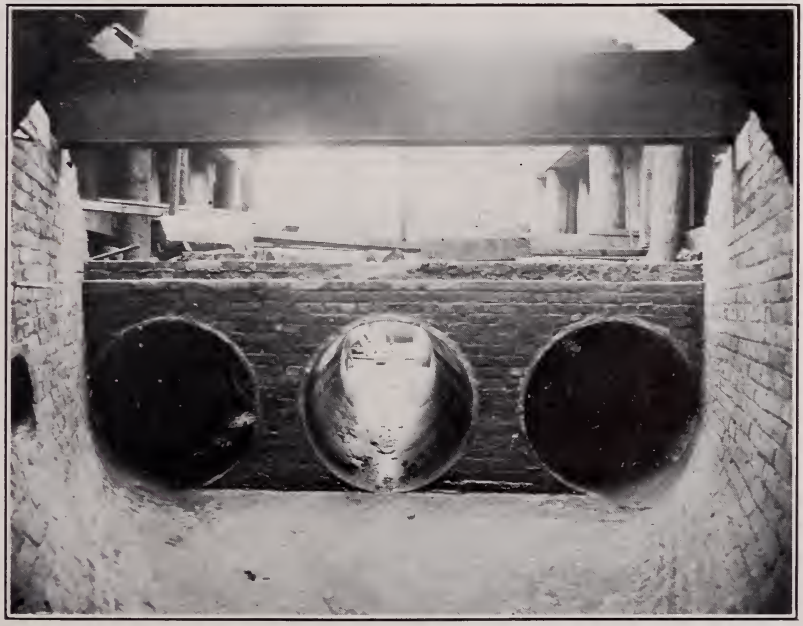
The 42d Street and the Fourth Avenue constructions have been the most objectionable of the whole work, but those sub-contracts were made at a time when it was questionable if the City could get a bidder, and in writing the original specifications the contractor was allowed liberties which have not been allowed in the consideration of the Brooklyn contract. He was allowed to have some material deposited on the streets, and was permitted to make excavations by forming an open trench and keep it open in almost any place desired. In the letting of the Brooklyn contract, the contractor was compelled to conduct his work in a different manner, without interference of traffic and without seriously obstructing the streets. The work now going on in the lower part of Broadway is something that I hope you gentlemen will watch, and I think that you will be pleased at the way in which it is being done. The work in front of the Park Row Building where many of you gentlemen have your offices, has been in the last four or five months, and on the east side of Park Row, *i. e.*, on the opposite side of the Post Office there has been a trench dug about 12 ft. wide and about 20 ft. deep, and a cable-way erected over that trench, and material from the whole street taken out, and the street kept in place, notwithstanding that there are four tracks of surface roads to be supported. It has been a pleasure to me to see how that work has been done, and done practically without the knowledge of the people on that street. They did not know, and some of them to-day do not know, that the work has been completed. It was supposed that the trench dug there was about all the excavation which had been made. I can tell you a story about that work which shows its magnitude, and how often those in charge of the work will know little of what is going on. One of the contractors saw the sub-contractor of this Park Row section, and said, "Why don't you put more men to work on this section," adding, "I have been here and I have my office in this building and see only about 20 or 25 men at work. It seems to me you ought to put more men to work." The sub-contractor remarked: "Do you know that we have had 200 men at work on this street for the last six weeks and that there is no more excavation to come out of the street." That gentleman was the head contractor. He had not gone into the trench; had not seen the work, and thought it was operated only as seen from the surface.

In lower Broadway an attempt is being made to temporarily replace the surface of the street by planking, and then pursuing the same method as pursued in Park Row, with the shafts in front of St. Paul's Church. Lower down on Broadway it is proposed to keep the surface of the street intact as long as possible and pursue the same course of taking out the excavation.

The East River problem is a serious one. There is a tunnel 1½ miles long extending from South Ferry to Joralemon Street, Brooklyn, and at the present time there are two shields working to the east in Joralemon Street through a dry sand. Eventually, or within two months, there will be two other shields which will work down hill, and go into the water section. At the present time those two shields

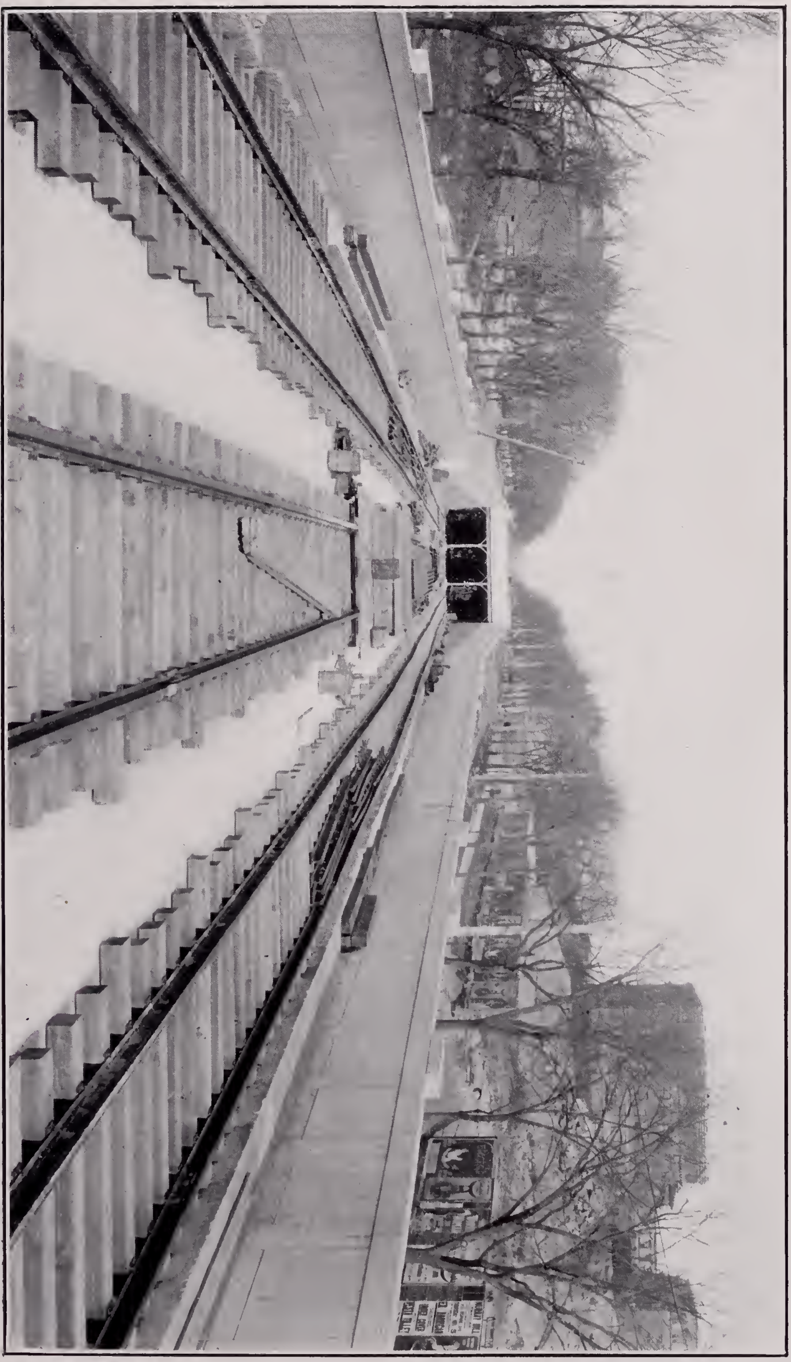


110TH STREET SEWER.



110TH STREET SEWER, DECEMBER 10, 1900.

PLATE VIII.



BROADWAY AND 124TH STREET, NOVEMBER 15, 190

are working without having any trouble so far as the water is concerned. In Battery Park, there are two shafts, and excavation is made underneath the elevated road. They have gone to the south about 200 ft. which I will show a little later by the stereopticon. The rock extends on the Manhattan side nearly to the middle of the East River; beyond that and in Brooklyn the material is sandy and has some clay mixed with it, and, of course, there the problem will be a little different from what it will be on the Manhattan side, although I think the Contractor will be obliged to use compressed air to guard against it on the Manhattan side in the construction of his tunnel.

The stations as designed by the Rapid Transit Engineers are to be ornamental. About eighteen months were occupied in designing the first station at 59th Street. I wish when you gentlemen go up that way you would take a look into that station, which is the first completed, and it will show you a general idea of the construction which is to be followed on all the different stations, except the ornamentation will be varied in the different parts of the work. There will be lavatories on both sides of the stations for men and women, both pay and free. The contractor has not spared any money in carrying out the requests of the Commission. He did not calculate in the beginning to put so much money into these different stations and into the operation of the road. In the building of his power station he will spend more than double the amount he originally intended to spend. His original estimate of equipment was about $8 000 000 and the changes probably will aggregate about $18 000 000. The power station is not paid for by the City, but he has to furnish it, for which he is remunerated by means of the operation of the road. It is located at 59th Street and the North River, and has a capacity of about 135 000 horse-power. It will be the largest power station in this country, if not in the world. The tracks, of which there are 20 miles already laid, are to be 100-lb. rails, although the contract calls for an 80-lb. rail.

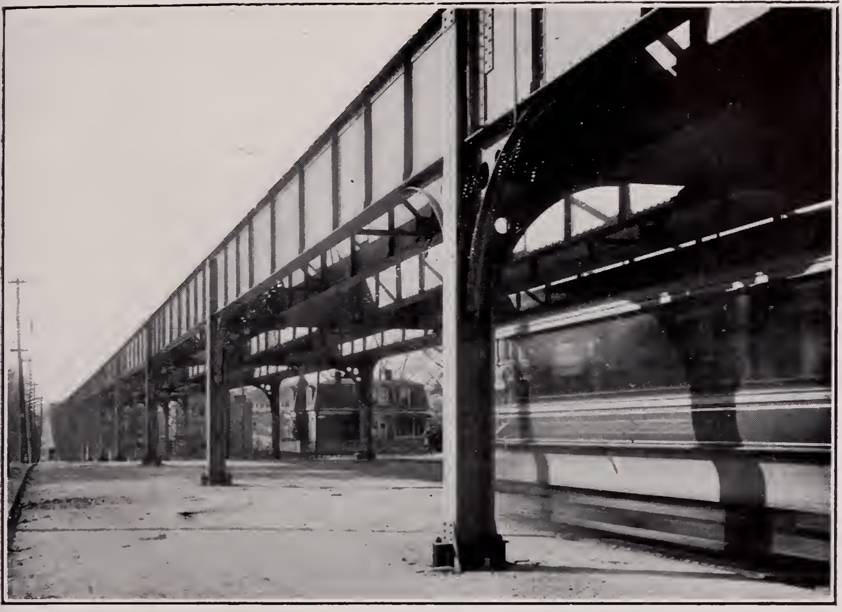
A great deal has been said in connection with our rapid transit work in regard to accidents. It cannot be said that no accidents will occur; provision, however, has been made against a recurrence of the accidents of the past.

When the original contract was let—the McDonald Contract—(it having been drawn up in 1898) it was not specified that electricity should be used because it was considered possible that a more efficient power might be discovered and put into use; hence, in the original contract, no mention was made as to the kind of power to be utilized.

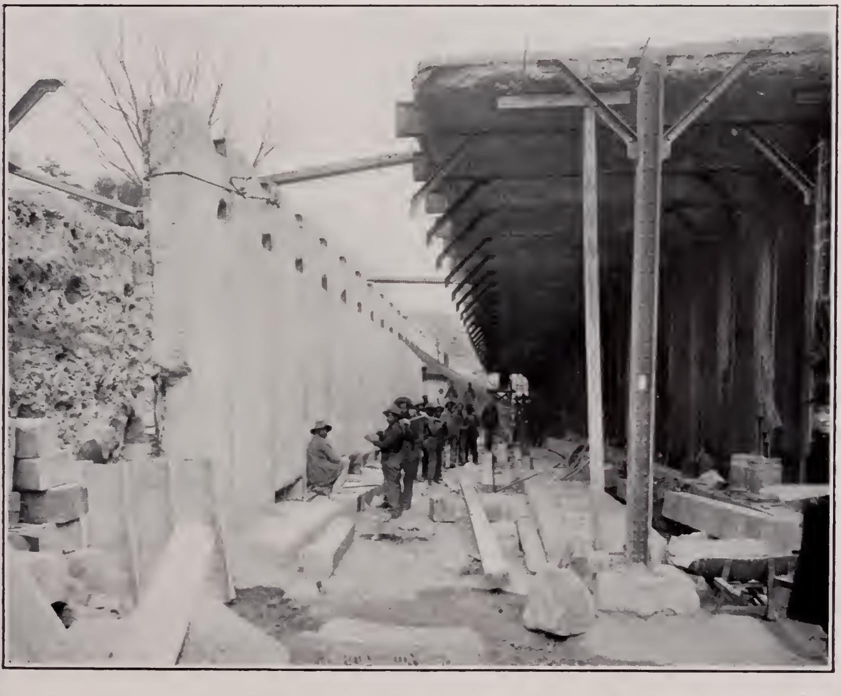
After the execution of the contract the Contractor elected to use electricity, and requested that the ducts be put in the side wall of the subway. This has been done. There are sixty-four ducts on each side along a large portion of the subway, and in these are to be built the cables for the power. There will also be independent ducts for conveying power for lighting which are entirely independent of the inside of the subway, and are independent of each other, so that if one should become defective the probability is that no interruption in the service would occur.

The local stations are in the lower part of the city and are about five to the mile, where the subway has been made wide. A four-track subway is about 50 ft. wide, which allows 12½ ft. between centers, and in the case of an accident the opportunity is given for the passengers to alight from the train so that they would not be in danger from the third rail, which is to be covered. On account of it being a separate system it does not seem that we could have the same accident that happened in the Paris subway.

I do not know whether you gentlemen have realized what is going on in New York on the question of transportation when you consider the question of dollars and cents. It is to my mind stupendous to note the amount of money which is to be spent in the next five years in this city and its vicinity upon the transportation problem. You have the Rapid Transit Subway, which involves an expenditure of something like $60 000 000, and you have the Brooklyn contract, in which the contractor gets $2 000 000 for work which will cost him $9 000 000; you have the Pennsylvania tunnel, which will cost all the way from $60 000 000 to $70 000 000; you have the New York Central improvements, which cost somewhere in the vicinity of $20 000 000; you have the Jersey trolley tunnel which is now over half completed across the Hudson River, which costs $10 000 000, and you have these improvements of the Pennsylvania Railroad for running its freight around through the Brooklyn section over the Island and connecting with the New York, New Haven and Hartford Railroad; you have your new Williamsbridge approach, and you have your new Manhattan Bridge



Westchester Avenue and Fox Street, November, 1903.



135th Street and Broadway, November 19, 1901.

PLATE X.

in course of construction, and the Blackwell's Island Bridge. Take all these transportation problems, for which large appropriations have been made, and you have (with some extensions of the subway which are bound to come) an expenditure of an amount estimated between $250 000 000 and $300 000 000. It is expected that all of these rapid transit systems will be completed within the next five years. I do not know of any other city or any other country that can spend such an amount for transportation purposes.

I have only gone over this subject in a general way for discussion. I did not have much time to prepare myself to talk to you, but thought that a general statement of the rapid transit problem, accompanied by a number of views, 100 or more of different portions of the work, would open the subject for discussion.

I am now ready to show the stereopticon views.

DISCUSSION.

Mr. Carr.—Mr. Rice has given an interesting account of the construction and a good general description of it. I do not feel prepared to give any more discussion on the details of my part of the work, and I do not think the meeting is prepared to hear such a discussion at this time of the evening.

Mr. Bischoff.—I would like to ask Mr. Rice a question regarding the ventilation of the subway?

The Author.—Yes, sir. As I stated in the course of my remarks, the principle of the design is, if you can maintain the pure air, then you are going to have good ventilation, and that is the purpose of spending so much money in keeping the air of the subway free and clear from moisture; and the trains, going as they will, between 30 and 40 miles an hour in the middle tracks, and 18 or 20 miles an hour in the local tracks, will keep the air in circulation. There has not been any attempt whatever to narrow the subway to a 9½- or 10- or 20-ft. subway, 12½ ft. being the centers. You will find a great many large, extensive railroads where they have their tracks less than 12½ ft. in centers; but this is liberal all the way through, so as to have plenty of air on the outside of trains, which are about 8 ft. wide and 8 ft. high, so that you can see the amount of space occupied by those cars.

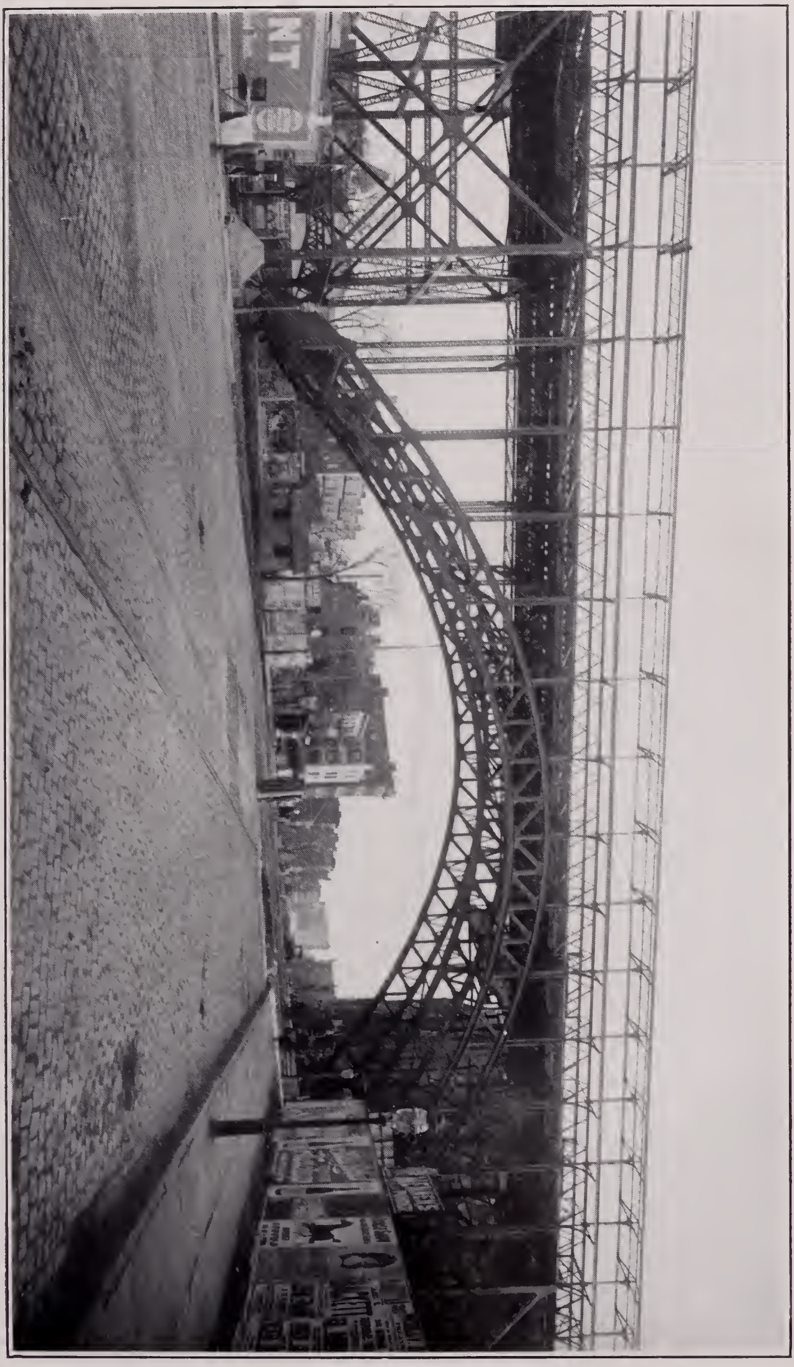
Mr. Lewis.—Mr. Rice, do you know of any other place where tunnels have been constructed where dependence has been wholly placed upon keeping moisture out, and where the results have been entirely satisfactory?

The Author.—No, sir. In the Boston subway I hoped that they would make a water-tight subway there, but they did not, and they had some trouble with ventilation at times; but they have provision there for fans, which are seldom used. I know of no place where they have constructed, as they have in New York, anywhere near a water-tight tunnel. Of course, it has not been done in New York in the tunnels, although a very complex and very large system of drainage has been made in those tunnels; but it has not been made water-tight. The subway itself will be made water-tight.

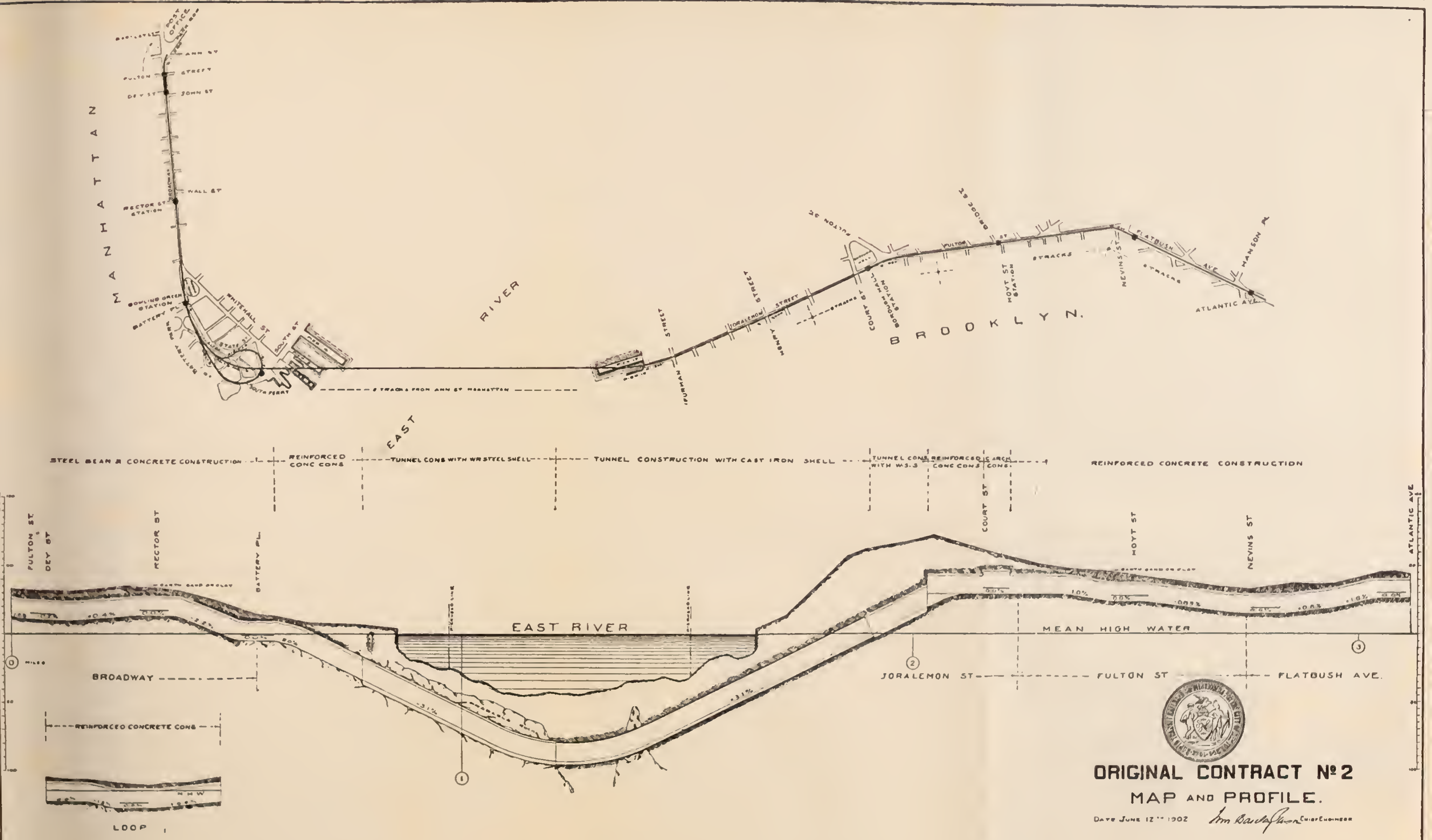
Mr. Lewis.—Will your asphalt coating, you think, be effective?

The Author.—We think so. It has been to a large extent. We have had some leaks and some trouble when the gas strikes it, but the asphalt has been good. Some leaks were very small and have been repaired. In one particular case, at 59th Street, there is a switch of the Metropolitan Street Railway between the surface of the street here; they keep that switch free by the use of naphtha. The result was we had some trouble, and we put in a lead covering and made a lead pocket by itself, so that the switch was entirely covered.

PLATE XI.



Manhattan Street and Broadway. November 15, 1903.



ORIGINAL CONTRACT No 2

MAP AND PROFILE.

DATE JUNE 12TH 1902 Wm Barclay Parsons CHIEF ENGINEER

Mr. Lewis.—Just asphalt all the way through and no tar?

The Author.—Yes, sir. Of course, the tunnels under the Harlem River and the East River are made of iron, and those structures will be absolutely water-tight.

Mr. Bischoff.—It has often occurred to me in this subway that the columns and the iron work, if got at easily, can be well preserved; but the upper girders, which may be more or less exposed to moisture, in time might deteriorate, and I was wondering if after fifty years the thing would not be rusted. What protection is there?

The Author.—I am sorry now, but I did not think of it at the time. I have some views which show the concreted structure where, instead of having any steel exposed, it is buried in concrete, so that the center columns are exposed in the whole of the Brooklyn structure, and also in the Lenox Avenue structure. Here we have a beam which is, say, 15 ins. high, and that beam is covered entirely with concrete; for instance, the beams are 5 ft. span. That beam is entirely covered with concrete on the top, on its sides and in only one space on the bottom, and we know that here it is protected by concrete, and even if that lower part would deteriorate it would not have very much deterioration.

Mr. Lewis.—In the general plan which you showed there was no suggestion of the subway on Broadway between Union Square and 42d Street.

The Author.—That has been talked of a good deal, and I believe that the contractors offered to build it for nothing if the way were clear.

Mr. Lewis.—How about the feasibility of making a deep tunnel in order to avoid surface disturbance.

The Author.—That question is under study, and I think the engineers have refused to discuss the question in the papers. The papers have been hammering the rapid transit work, and the engineers have refused to discuss it for the reason that the commission has never decided upon the route down through Broadway, and the question is being examined by the Rapid Transit Engineers with reference to a route, and, of course, nothing has been decided or will be said until those studies have been made. These are the facts in the matter. Nothing has been done with reference to the extensions on Broadway. That scheme, as you say, was suggested by the contractor, who would build for $100 000 that section from 42d Street down to 14th Street, but would make no direct connection. He did not intend to connect with the subway portion. I think that eventually, if any lines are to run down in that direction, whether they go down Broadway or Seventh Avenue, they should be continued to the lower part of the city. Mr. Belmont's proposition was, to go down as far as 14th Street.

THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.

Paper No. 4.

SOME STREET TRAFFIC PROBLEMS.

By Wisner Martin, Member of the Society.

Presented October 28th, 1903.

The great problem of regulating the movement of vehicles in the streets of Manhattan, the rigid enforcement of the best rules for safety, convenience and speed, is probably the most important one awaiting solution which aims for public improvement in this city.

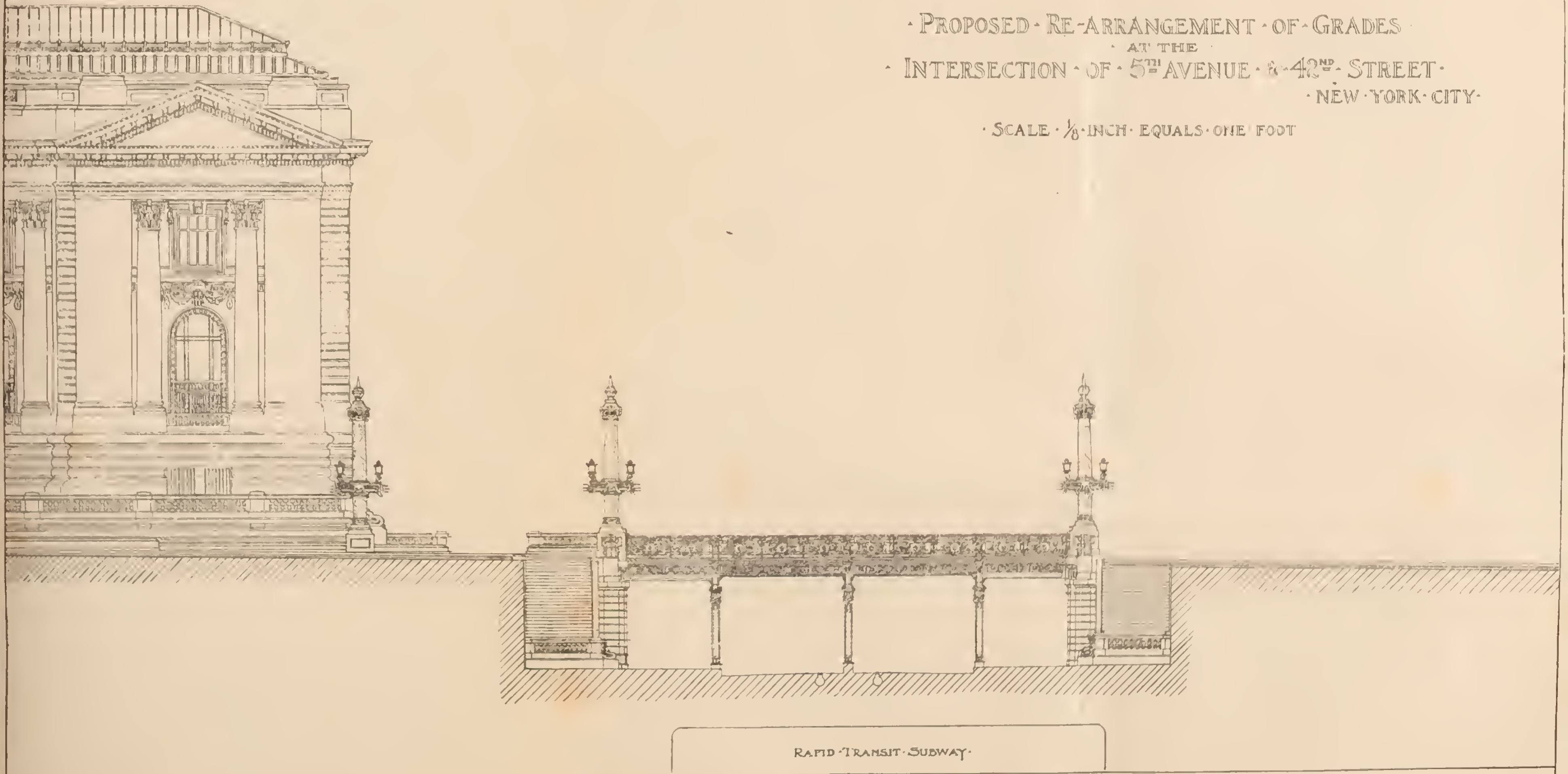
The rigid enforcement, however, of the most comprehensive rules of the road would still leave certain of the more congested points for special treatment. Indeed in the operation of the surface street-railways the number of cars which can be run over a whole line is only as great as the number which can be passed over the most congested point on the line in a given time; and this theorem is true, only in a less degree, for vehicles which are not confined in their movement to the fixed line of the car tracks. So that the solution of these special cases is only slightly less important than that of the general problem. It is to some of these special problems that I ask your attention.

Fifth Avenue and 42d Street.

The intersection of Fifth Avenue with 42d Street is a dangerous street crossing for pedestrians and a very difficult point to pass, even at ordinary speed, for vehicles. The reasons are these: Fifth Avenue is the finest avenue in the city. It is very long, is in the center of the borough, and is lined with the most costly dwellings, hotels, clubs and business buildings, the occupants of nearly all of which use vehicles of various kinds. They are constantly passing up and down this great highway and are added to by the many others which use this

PROPOSED RE-ARRANGEMENT OF GRADES
AT THE
INTERSECTION OF 5TH AVENUE & 42ND STREET
NEW YORK CITY

SCALE 1/8 INCH EQUALS ONE FOOT



TRANSVERSE SECTION THROUGH 42ND STREET
ON LINE A-B-C-D-E-F

street as a great thoroughfare to go upon for the whole length of the island. 42d Street too is a crowded one. It is a main crosstown thoroughfare and upon it is an important street-railway. It has many business buildings and hotels along it, and on it is the terminal station of three very important railway systems. Between 42d Street and 56th Street there is no street which crosses the New York Central Railroad in such a manner that heavy trucks can use it, so that for half this distance, or from 42d to 49th Street, the crosstown traffic is diverted to 42d Street. West of Fifth Avenue too, 41st street is cut off by the Public Library and Bryant Park. This also adds to the travel in 42d Street.

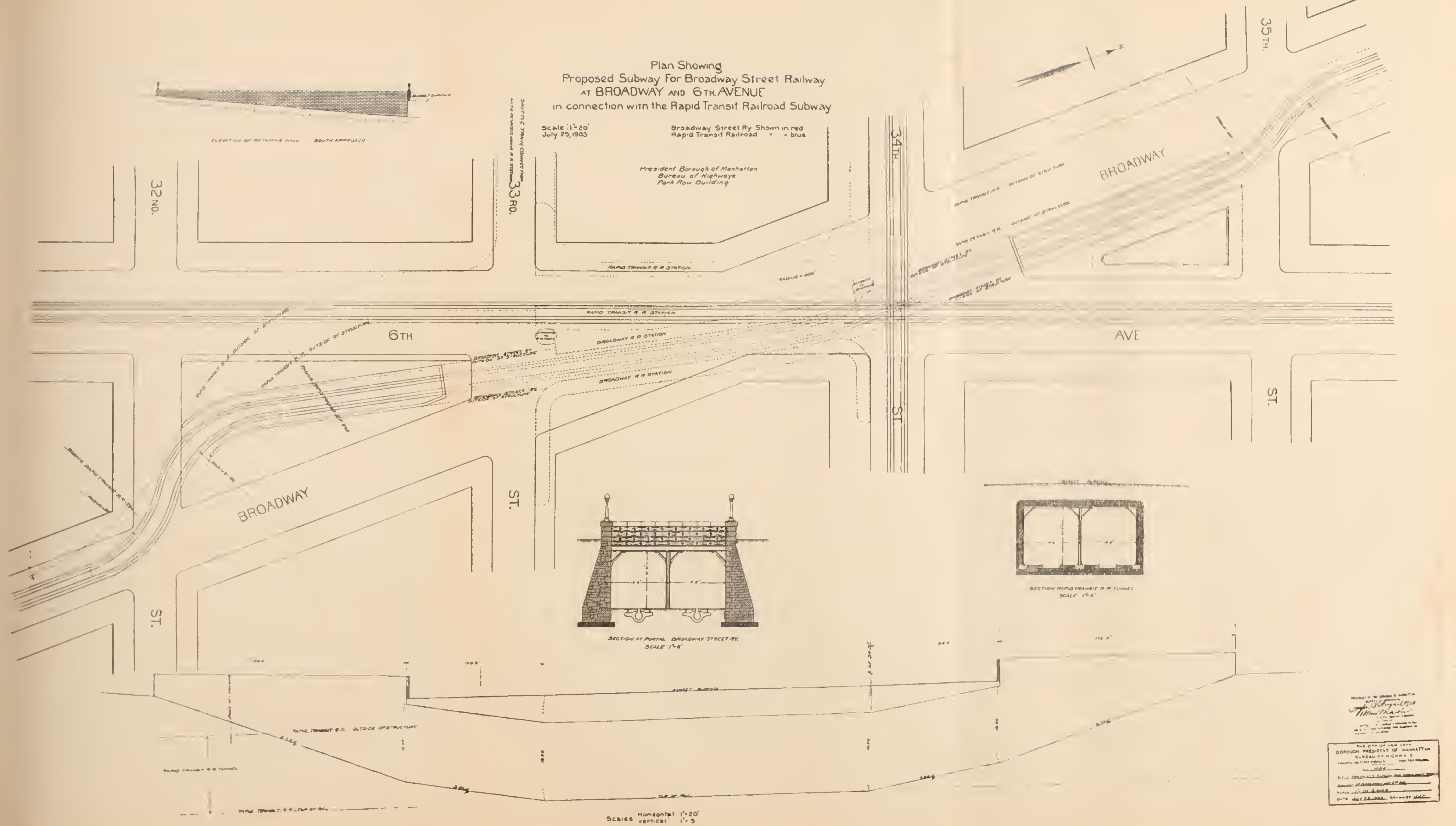
Thomas Hastings, Esq., of the eminent firm of architects, Carrère and Hastings, proposed the improvement here illustrated of an overhead crossing of Fifth Avenue.

Mr. Hastings' idea is to build a handsome bridge which will be a permanent adornment of the city and one which will relieve, to some extent, the monotony of long, straight, unchanging street scenes like that along the Fifth Avenue as is done in cities abroad and, also, to make the bridge a part of the general scheme of embellishment of the surroundings of the new Public Library. On the practical side it is a solution of the problem of the congestion of traffic at this intersection. The very desirable achievement of the purpose to remove the street-railway tracks from the surface of Fifth Avenue is one of the chief gains made by it. The rapid transit tunnel is so deep at this point that there will be no interference with it at all. It is especially fortunate that the present grades at this intersection permit the proposed treatment. There is no other congested intersection of the city where such a scheme could be well carried out.

A description of the project is this: That the surface of 42d Street, including the roadway and both sidewalks, be lowered at Fifth Avenue about 14 ft., and that the surface of Fifth Avenue at 42d Street be raised about 2.8 ft. The grade of Fifth Avenue from this point will run out to the present grade at 43d Street and at 41st Street. The new grade north of 42d Street will be a little steeper than the grade is at present. The proposed grade will be 2.3 per cent. It will be nearly the same from the traffic point of view as the present grade. The steepest grade which exists on Fifth Avenue now is that between 34th and 36th Streets, where it is a little over 3 per cent. The change of grade at Fifth Avenue south of 42d Street will be an improvement over the present grade. The new grades on 42d Street, both east and west of Fifth Avenue, will be uniformly 2%, and will be an improvement over the present grades, as the summit now existing at Fifth Avenue will be cut down. It is proposed to lower the sidewalks up to the fronts of the buildings and to change the steps and stoops and rebuild the front walls of the buildings so as to conform to the new grade. In some cases this will add a story to the buildings.

The bridge is to be of steel and the asphalt roadway and the sidewalks of Fifth Avenue will be carried over it at the full width that they have now. At the three corners of the bridge, against the three buildings, handsome granite staircases will be erected. The foot of each of these staircases will be 25 ft. east and west of the property lines on the avenue. On the library side of 42d Street there will be no staircase near the avenue. The retaining wall of the library grounds will extend from the bridge westward about 225 ft. Here, where the level of the library grounds is only 6 or 8 ft. above the sidewalk level, there will be a broad flight of steps. Under the bridge and behind the granite abutments of it on one side it is proposed to have a public comfort station, on the other side a news and fruit stand. In the center of the roadway of 42d Street is a row of columns supporting the center of the bridge, also a row of columns along each curbline of 42d Street. The street will pass under the bridge with the same width of roadway and sidewalks as at present. The bridge will be handsomely ornamented with marble standards and bronze lamps and bronze railings.

The estimate for the work complete is $330 000. This includes the retaining wall on the south side of 42d Street west of the avenue, which is part of the wall around the library grounds and which the city will have to build whether this present project is authorized or not. This much is estimated at $20 000. $100 000 is allowed for rebuilding the fronts of the houses on 42d Street down to the new street level, including the interior work which will be necessary and the rearrangement of the stoop-lines and steps of the Fifth Avenue houses. The water and gas pipes and electric conduits of Fifth Avenue will be carried under the abutments and under the new surface of 42d Street.



Plan Showing
Proposed Subway For Broadway Street Railway
AT BROADWAY AND 6TH. AVENUE
in connection with the Rapid Transit Railroad Subway

Scale: 1" = 20'
July 25, 1903

Broadway Street Ry Shown in red
Rapid Transit Railroad " " blue

President Borough of Manhattan
Bureau of Highways
Park Row Building

ELEVATION OF RETAINING WALL SOUTH APPROACH
32ND.
33RD.
34TH.
35TH.
SHUTTLE TRAIN CONNECTION WITH RAPID TRANSIT R.R. STATION
BROADWAY
6TH
AVE
ST.
RAPID TRANSIT R.R. STATION
BROADWAY R.R. STATION
RAPID TRANSIT R.R. OUTSIDE OF STRUCTURE
BROADWAY STREET RY. OUTSIDE OF STRUCTURE
RADIUS = 900'
SECTION AT PORTAL BROADWAY STREET RY. SCALE 1" = 6'
SECTION RAPID TRANSIT R.R. TUNNEL SCALE 1" = 6'
STREET SURFACE
TOP OF RAIL
RAPID TRANSIT R.R. TUNNEL
Scales Horizontal 1" = 20' Vertical 1" = 5'
THE CITY OF NEW YORK
BOROUGH PRESIDENT OF MANHATTAN
BUREAU OF HIGHWAYS
No. 1064
DATE JULY 25 1903

At the public hearing on this proposition much opposition was shown by the owners of buildings and businesses in 42d Street, because, according to the plan, carriages could not drive from the avenue directly into the street. This difficulty, however, could be obviated by cutting a street north and south through the center of the block between Fifth and Sixth Avenues from 42d to 43d Streets. It would correspond, on the west side, to Madison Avenue on the east side of Fifth Avenue.

The design has been wholly worked up by Carrère and Hastings and the engineering part by the author.

BROADWAY, SIXTH AVENUE AND 34TH STREET.

At the intersection of Broadway, Sixth Avenue and 34th Street three double track street-railway lines intersect, with a consequent street car congestion in the busy hours which is the worst in the city. It is unnecessary to describe fully the conditions existing here as the object of this proposed improvement is to facilitate the operation of the street-railway only. It must be taken into account, however, that the vehicle traffic, besides the car traffic, is very heavy.

This crossing is the controlling point of the maximum number of cars which can be operated over the three lines intersecting here. During the rush hours nearly 600 cars an hour pass this point on all lines at a speed of about 7 miles an hour. More than 200 cars an hour pass on the Broadway line, less than 200 on the Sixth Avenue line, and still less on the 34th Street line. It is possible to operate more cars than this but not with the proper degree of safety to pedestrians and passengers.

The plan here shown is intended to provide a tunnel for the Broadway cars to pass through from 32d Street to 35th Street, thus permitting the removal of the present tracks on Broadway between these points. It is designed to permit also the construction of the proposed rapid transit subway under Broadway. This improvement would leave only a right angle crossing of the Sixth Avenue and 34th Street lines on the surface and would make the roadway crossings much less dangerous for pedestrians than they are now. It would also provide isles of safety at the entrances and exits in the center of the broad roadway intersections.

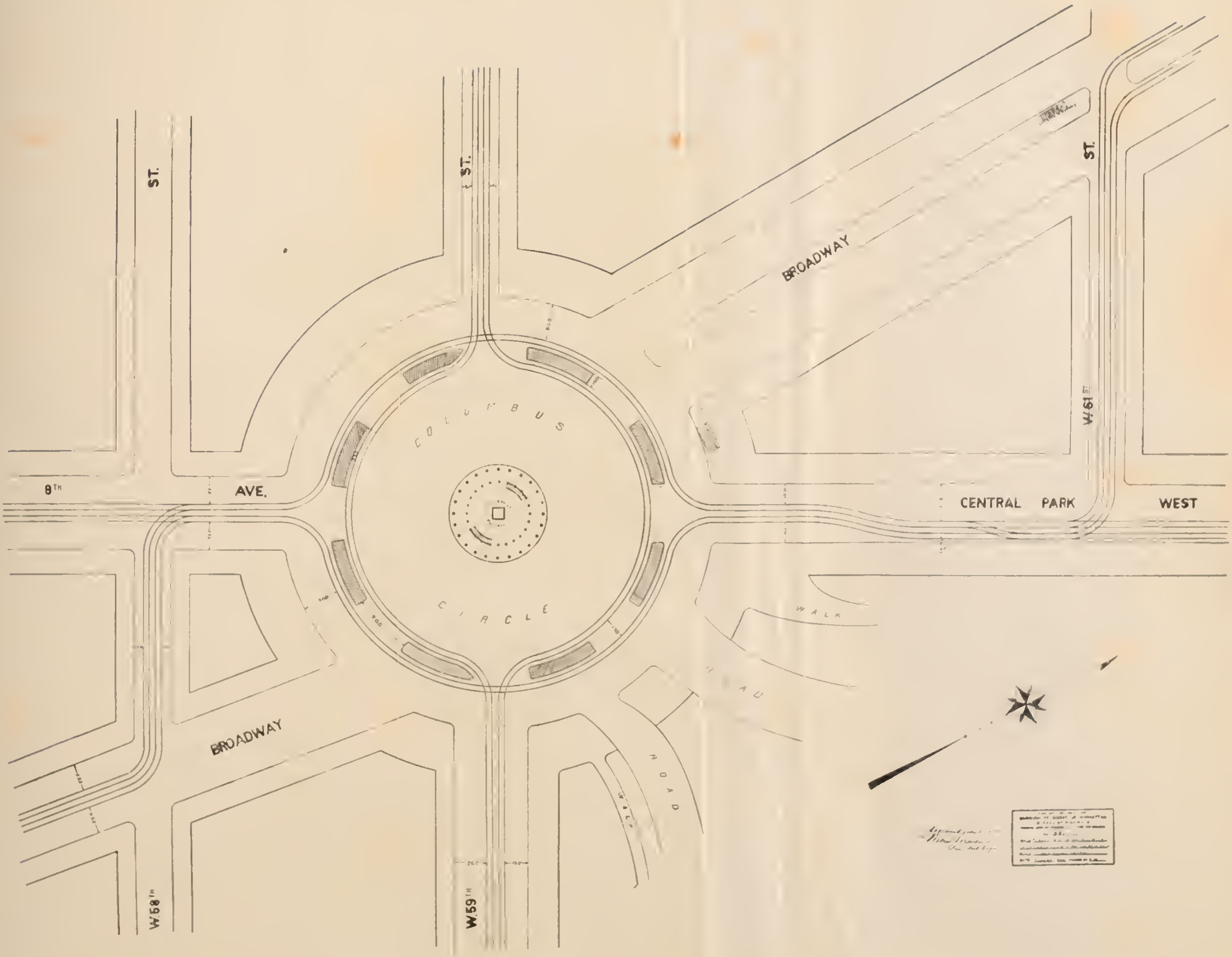
The plans show the rapid transit subway curving to the west at

32d Street and then running along the west side of Sixth Avenue and back into the center of Broadway above 35th Street. A spur tunnel to the Pennsylvania Railroad terminus for shuttle trains is shown in 33d Street. The Broadway line tunnel is at the same grade as the rapid transit tunnel and is to be built at the same time. This arrangement leaves room for the Pennsylvania Railroad tunnel to pass beneath both of them. The Broadway tracks also curve to the west at 32d Street passing over the rapid transit subway and into the approach to the tunnel in the triangular park in Greeley Square, descending at a grade of about 8½% and passing under this square and Herald Square and ascending at a grade of about 9% to the surface of 35th Street in the triangular park, and then back to the present Broadway tracks to the north. These grades are safe, being about that on Amsterdam Avenue north of Manhattan Street. This plan affords opportunity for surface railway passengers to pass to the subway railway cars conveniently on adjoining station platforms.

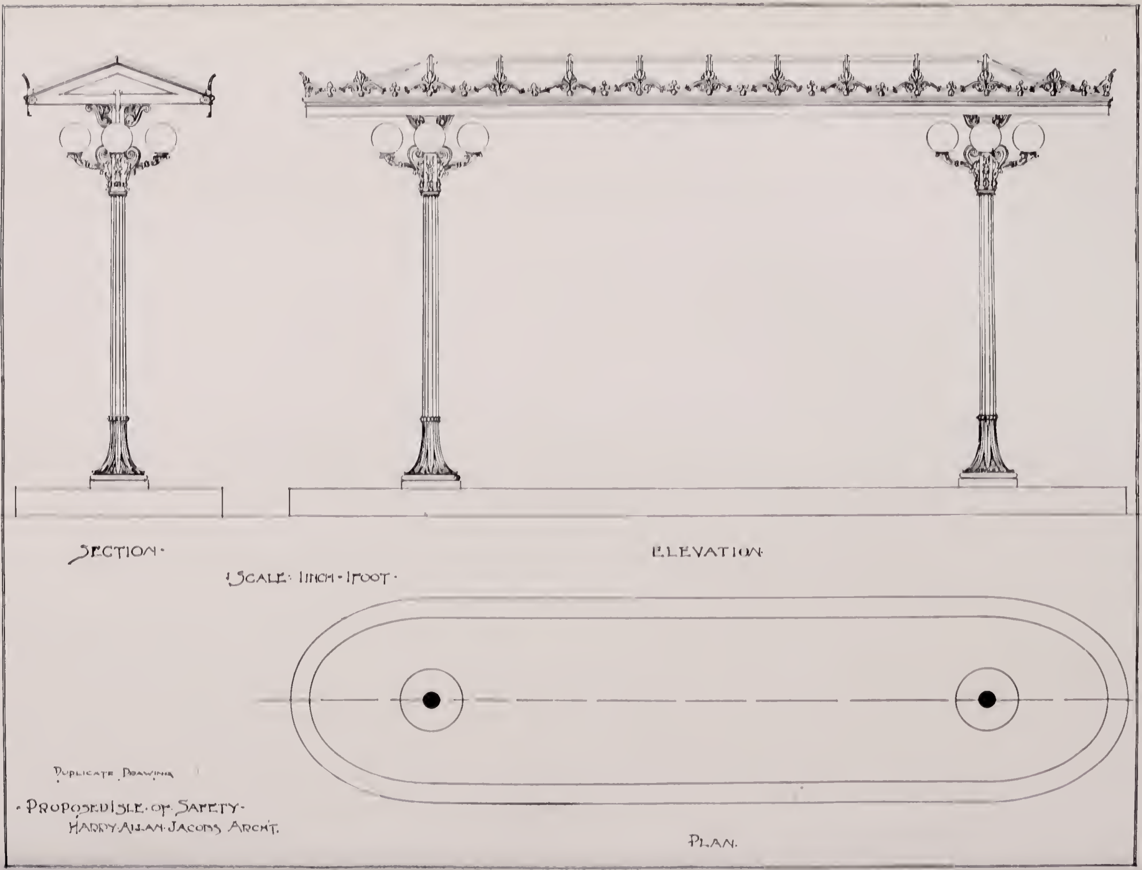
The excavation would be entirely in solid rock. The estimate is $200 000. The idea of removing the Broadway tracks and putting them in a tunnel originated with the consulting electrical engineer of the State Railroad Board and the plan was made by the author.

Columbus Circle.

Another improvement is the proposed rearrangement of tracks and the building of transfer platforms at Columbus Circle. The conditions to-day at Columbus Circle in regard to the travel of both vehicles and pedestrians, are deplorable. They are dangerous and very inconvenient.' As the street-railway tracks are now laid across the Circle it is not possible to regulate traffic at all. .A person driving into the Circle, for instance, from Eighth Avenue, with the intention of entering the park, must drive in and out among cars and other vehicles going "every which way." The danger and inconvenience may be imagined as far as the driver is concerned. Both conditions, however, are far worse for a pedestrian who is compelled to cross this chaotic roadway. The conditions also are very dangerous for people who transfer at this point. From at least half of the cars, such passengers have to alight and wait on the roadway and there are three important lines of double track street-railways intersecting here, so that the number of people transferred at this point is very large. In order to


ST.
ST.
ST.
BROADWAY
COLUMBUS
CIRCLE
8TH
AVE.
W. 61 ST
CENTRAL PARK WEST
WALK
ROAD
ROAD
WALK
BROADWAY
W. 58TH
W. 59TH

Isle of Safety, Fifth Avenue and 23d Street.


SECTION·
ELEVATION·
·SCALE·1INCH·1FOOT·
DUPLICATE DRAWING
·PROPOSED·ISLE·OF·SAFETY·
HARRY·ALLAN·JACOBS ARCH'T.
PLAN.

remedy these defects and to improve the appearance of the Circle and the entrance to the beautiful park, the Municipal Art Society has proposed that the tracks be laid as shown in the illustrations and that transfer platforms be placed between the two circles of tracks. It is proposed that these transfer platforms have awnings over them in order to form a shelter from rain.

By these arrangements there are eight transfer platforms so that a person can transfer to any point by stepping from a car to the proper transfer platform and waiting there for the car to his destination. Passengers from two cars on one line can be transferred to two cars on another line at the same time. These platforms also provide isles of safety between the sidewalk on the outside of the Circle and the sidewalk around the monument at the center, which can be used as a refuge for pedestrians. With the tracks placed as proposed, the cars will follow around the Circle in one direction, so that the street traffic of vehicles can be made uniform and all of the vehicles upon entering the Circle will turn to the right and continue to the right until they leave it.

The Municipal Art Society which presents this plan, proposes that some time in the future and not as a part of the present plan, the Columbus Monument be raised so that it will stand on top of a handsome Grecian colonnade which may be used as a rostrum for public speakers or for a band stand, and that underneath this colonnade a public comfort station be placed. When this is done the center part of the roadway, almost out to the inner circular track, can be used for people to stand upon while listening to the band or the speaker.

The cost of the improvement, exclusive of the work under the monument, including the building of the new lines through 60th Street and through 58th Street and the removal of the tracks from Broadway, between 58th and 60th Streets, is estimated at about $50 000.

ISLES OF SAFETY.

An illustration of the isle of safety erected by the Municipal Art Society at Fifth Avenue and 23d Street is shown as a means of providing safety for pedestrians at dangerous roadway crossings. A proposed design of another is also shown.

There was no discussion of this paper.

THE MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK.

Paper No. 5.

THE PROBLEM OF THE MAINTENANCE OF ASPHALT PAVEMENTS IN MANHATTAN.

By Dr. J. C. Bayles, Member of the Society.

Presented November 25th, 1903.

Through a misunderstanding, which no doubt was my fault, I find myself called upon to discuss a subject to which I have no intention of referring in the remotest degree. The subject which I shall have the pleasure of discussing is "The Problem of the Maintenance of Asphalt Pavements in the City." This has been somewhat crowded upon my attention of late by the request of the Commissioner of Public Works of Manhattan to investigate it for him and the results of that investigation digested and summarized are the only paper I shall be able to give.

The condition of the streets of New York has been a scandal and a reproach for years. I believe that a speaker on this occasion is ready to say what he pleases without embarrassing the Society in any degree in the matter of endorsing his views. It has been especially so since the cobblestones and Belgian blocks of the earlier period of municipal development gave place, first, to wood and then to the asphalt, which, *per se*, of all surfaces best meets the requirements of the modern city. It is, however, the form of pavement which least accommodates itself to the constant excavation necessary to give access to subterranean pipes, ducts, sewers, house drains, service pipes and wires. No sooner is a street made smooth and beautiful with this elastic and tenacious surface than the necessity arises for piercing it here and there, and often trenching it longitudinally and transversely, until it is seamed and scarred in every direction. Bad as are the conditions due to this constant street excavation, those which would arise from the refusal of the municipal authorities to allow it would be incomparably worse. Neglected gas and water leakage, the congestion of sewers, street and house explosions and the restriction of electrical communication, would make New York uninhabitable, not merely in a figurative sense, but literally. The average citizen sees but one side of this question. He knows little of what is going on underground, but is profoundly concerned with the constant street obstructions from which he suffers, deplores the apparent unthrift of the municipal administration in providing excellent and costly pavements only to permit them to be quickly and utterly destroyed, and is incensed at the apparent negligence which characterizes the action of those who should hasten to repair the ruthless damage thus inflicted upon the most valuable of public assets—our streets and avenues.

Some of the causes are very obvious and well known; others perhaps less so. One of these interested me especially and has reference to the action of gas upon the under side of asphalt pavements, destroying the binder and ruining the wearing surface. About two years ago, I had occasion to determine experimentally in Brooklyn whether gas is found under asphalt and how it acts in that position. The question at issue was whether the company which laid the asphalt was responsible for the deterioration of the pavement in spots and should be required to mend such spots under their maintenance contract. Its officers claimed that the pavements had been laid in large sections from material of uniform quality and under uniform conditions. The wear was measurably equal along any given street, and if the pavement failed by reason of defects in the material or laying, it should have failed all over and not in sharply defined spots in what seemed an arbitrary distribution. In a dozen or more avenues and streets examined the areas of local deterioration had characteristics in common. Their superficial indications were bowl-shaped depressions marked by parallel striations. In a large number of typical depressions of this character—more than a hundred in all—in neighborhoods separated by considerable distances, holes were cut through the wearing surface with suitable tools, and in every instance the binder was found to be spongy, rotten and, in many instances, semi-fluid. Twelve to twenty-four inches away in any direction the binder was usually as solid and tough as when laid. Whenever we found in these streets that were examined one of these bowl-shaped hollows, a bar was driven after the crude method of sounding for gas in soil supposed to contain it. In those bar holes we found in every case gas in very large and very dangerous quantities. The first test made of the bar hole was to apply a match and we got a very sharp tonation. When that had passed we could then maintain a flame from 6 to 12 ins. high burning continuously until extinguished. Before this firing was tried, I took a reading of the air in these holes to determine the presence of gas and the quantity present by a rather delicate color test, which gives, I think, invaluable results. I have some of these results with me and they are sufficiently visible to be seen without passing them around. If explained to you what they are, I think the eye will give you a clear indication of the results. These slips represent the test made for gas in bar holes. They are taken as the *A* and *Z* of the scale. The other slips on both sides of the page represent the quantities of gas found and the proportions in those bar holes may be judged by comparing the color of these slips with the blacker stain on the standard or test slip at the head of the page. There were no omissions in making these records. Thus, no negative results were omitted. They were given just as they occurred. I have on this test record a number of additional slips of further tests made in Brooklyn. These stains on the paper in white represent the quantities of gas, ranging from, I should say, 10 to 20%, or possibly 20 to 30 per cent. The color scale is a delicate one to determine, but in every case in these bar holes the gas was found in rank quantities. The holes were then excavated, men were set to work to dig down, and in every instance was found a bad leak either in the main under it or in the service pipe leading from the main. The gas leaking from the main or service pipe had worked its way up through the soil until it struck the binder of the under side of the asphalt. It carried with it the solvents which makes the water gas of Brooklyn non-luminous and which are very high solvents in bituminous material. These had acted upon this asphalt, converting it into a consistency something like warm molasses candy—very sticky—and without any value for the purpose for which it was employed. The weight of the wheels on the surface, which was not materially affected by this gas action, had depressed the wearing surface by squeezing the soft and plastic binder out of position and allowing the depression to get gradually deeper and deeper until the hole responded, which would have destroyed utterly the pavement in that section. We found also in bar holes put down outside of these areas pronounced depressions. Where these bowl-shaped depressions occurred, we found, very singularly, the same quantity of gas, and that was a puzzle for a time, and then it was shown very clearly why it was so. Non-luminous water gas has no action whatever on asphalt, but what does is the added naphtha vapor of the carburetting process which is used to make water gas luminous. When the hydro-carbon enrichments are exhausted, the gas might go five miles under the asphalt and do no further harm. Consequently, we find in cellars and in sewers nearly as high percentages of dangerous gas as we find under these rotten spaces in the asphalt pavements, but we do not find in them any solvents of asphalt. Those seem to dissolve themselves immediately over it. This depression is going on all over the country and it is an extremely serious problem. It is one that has never been thoroughly investigated or dealt with, and in the case of Brooklyn the trouble was that the asphalt contractors did not care to bother with them any further and the city repaired the pavement, relieving the responsibility of the Gas Company. There may have been a reason for this but it certainly was not good policy, I think, in view of the great cost entailed by the city in repairing the damage which the Gas Company was responsible for.

There is another source of injury which is going on constantly and rapidly, and for which the persons who lay asphalt pavements are not responsible, and that is holes in the asphalt due to the presence of manhole covers in the streets. Iron covers rarely begin, and still more rarely long remain, level with the street surface. Naturally, they wear less rapidly than the asphalt. A wheel striking one of them jumps, passes over it and then drops off, with the result that in a very short time a hole is pounded out on both sides, which makes a dust pocket in dry weather and a mud hole in wet. The wear around a manhole is usually very much greater than in any other portion of the street. That is also a reason for which the asphalt company is in no degree responsible. It is going on all over the city, however, and accounts, in a large degree, for the unsatisfactory character of the asphalt pavements in many streets.

Of the street openings which are made for corporate purposes, the facts are so well known as to call for very brief comment. The statistics have been published repeatedly and are very startling, running very high into the thousands of openings, but the terms "necessary" and "unavoidable," as applied to street openings, are in a sense misnomers. As here used, they mean openings which, with our present crude system of running pipes and ducts underground wherever room can be found for them, covering them in and leaving them exposed to the destructive influences of soil contact, frost penetration, expansion and contraction, jar, shock and vibration, cannot be avoided. New York can never rank as a city of the first class as long as this relic of a crude and imperfectly developed civilization is permitted to exist. You may recall, perhaps, the exceedingly humorous remark of an old lady on a bridge, saying: "Is this Broadway?" "Yes, Ma'am." "Well, where are they taking it?" That excavation, without any more interruption, would have given us pipe galleries and left the streets free from any thereafter.

But, however desirable, pipe galleries are improvements for which we must look to the indefinite future. Whatever beginnings are made in connection with subway extensions now in hand in Manhattan and Brooklyn, it will necessarily be a long time before all the important streets and avenues can be thus provided, so it can be said of any one of them, as the City Engineer of Nottingham, England, said of Victoria Street in that city—its busiest thoroughfare, in which is situated the General Post Office: "There are, besides the gas and water pipes and connections, no less than six pipes containing telegraph wires in this subway, and not one stone was disturbed in this carriageway for twenty-five years, and in that time not one single penny was spent on repairs in this street." Think of an important street in New York which needed no repairs in twenty-five years, which remained undisturbed by intrusive excavation during that time, and in which not a stone or its equivalent was lifted by the day-laborer's pick! When this, or anything like it, can be said of the streets of New York, it will have attained the dignity of a city of the first class. We thus see from this English experience how universal experience of this kind is. Speaking of the universal experience, in fact, any one who has ever read the exceedingly fascinating story of the report of Frontinus, a water engineer of renown in the first century, will see that his experiences were identical with the modern water-works engineer. Eighteen centuries does not seem to have changed human nature in the slightest degree.

Corporations occupying streets under franchises receive permits to break pavements on the express stipulation that they shall repair the damage done by them and return the pavement to the condition it was in before their work was done. This is a contract obligation in which "specific performance" is impossible. Mr. A. Brown, Borough Engineer of Nottingham, England, describes in his city conditions so closely approximating those existing in New York that a quotation from him will have more interest, and perhaps accomplish a better purpose in showing the universality of what we have regarded as a local grievance, than an original statement of similar facts:

> "There are now (under the streets) the main sewers, gas and water pipes, with their innumerable branches, telegraph and telephone wires, and in the larger and more important streets, pipes for carrying hydraulic power and compressed air, pipes and conduits for electric light cables, conduits for cable tramways for electric tramways; and if the lead of our American friends is followed we shall have to add another pipe for carrying steam for power and for heating purposes. * * * Considerable difficulty is experienced in dealing with this complex system; the surface of the roads is cut into, almost over its whole surface, for the purpose of laying and replacing from time to time the various pipes referred to, and the borough engineer is expected to maintain the surface in a good condition after the operations of various people who disturb the paving, and who have very little interest in relaying or maintaining it satisfactorily. It does seem to be somewhat of a blot on our boasted civilization that when a pipe has to be taken up, in a busy and crowded thoroughfare, the system usually adopted is to tear open the street, whatever the class of pavement may be, lay in the pipes and then 'make good' the surface. Those two words—make good—cover a lot of ground, but are somewhat misleading; it is as much an engineering impossibility to immediately restore the paving over a newly-filled-up trench to it its original condition as it is to heal a serious wound on a human body without leaving a scar."

One of the difficulties in "making good" is the purely physical one that it is almost impossible to replace in a hole in the ground what has come out of it. Nature packs earth better than man can do it, and time is an essential element in solidification. When all has been replaced which can be accomplished by wetting, pounding and tamping, something remains which will not go back, and which has to be carted away or scattered. The result is a looser back-fill than the body of the soil in which it is made. The loose column of earth gradually settles by natural readjustment and the asphalt or other pavement over it is less adequately supported than that on either side of it. Thus, with no purpose of neglect on the part of the company obligated to "make good," the best repairing which can be made does not make good the damage done by excavation, and subsequent mending devolves upon somebody, if the street is to remain smooth, level and free from sinkholes. The condition of a permit to cut a street, that the company receiving it shall not only have all the pavement taken up restored in a "first-class manner," but shall maintain it in that condition for two years, does not really meet the difficulty, and cannot. In a pavement punched as full of holes as a kitchen colander, it is impossible to accurately apportion responsibility where it belongs, or to enforce a requirement when grounds for a reasonable doubt exist as to who should be looked to to correct deterioration. In the winter of 1900 the writer saw from the windows of the house he occupied in one of the uptown streets of New York thirty-eight openings made between January 15th and March 30th within a distance of 200 ft. Each of these openings was large enough to admit two men. In some instances their boundaries overlapped. The result was that notwithstanding the constant patching of the asphalt the street surface was practically destroyed before spring. The work of restoration was not apparently "scamped," but much of it was done perfunctorily and with any material the company doing it had convenient. The average delay in mending one of these holes in the pavements was about fifteen days, but some of them remained patched with stone paving blocks all winter. In front of my present residence there were for some months two holes in the asphalt pavement, one about 4 by 8 ft. and the other about 5 by 5 ft., filled in with loose planks, which are occasionally thrown out of position by the wheels of passing vehicles, and are sometimes stolen by the boys for purposes of their own. They remained in this unsightly and dangerous condition until the repair gang came. The holes were not more than 12 ft. apart, but only one of them was mended. The other remains in its original condition, doubtless because it was not cut by the same people or for the same purpose as the one which was ultimately repaired. Consequently the repair gang and road roller summoned for the one passed by the other. No doubt they were warranted in doing so, but it would have better served the public interest and avoided an expensive duplication of effort if both holes cold have been mended at one and the same time. The case is mentioned because typical. The duty of "making good" in these instances has been sadly neglected.

The General Repair Contract may or may not be a success. It imposes what would appear to be impossible conditions upon the company which took it. It is required to repair defective asphalt pavements wherever found in streets not covered by an unexpired maintenance contract, and maintain them in good condition for one year. The area of asphalt pavement in Manhattan which has become a public charge through the expiration of the maintenance obligations embodied in the original contract is at present 228 445 sq. yds. This area is constantly increasing. Much of it, through imperfect repairing, reverts to the city in rather poor condition and the amount of work demanded to put and keep it in good condition is considerable. Frankly, I find it impossible to feel any confidence in the success of the experiment of the General Repair Contract, looking at the probable results from the point of view of the public interest.

The result of my investigation leads me to the conclusion that the solution of this problem, *i. e.*, so far as Manhattan is concerned, is in the establishment of a Municipal Repair Plant, which shall take charge of this work and do it when and as it needs to be done, with the responsibility of the officers in charge of the Department as a guarantee. The Borough President, in looking at this matter from his point of view, desired to be informed on certain points in his mind. The first was, whether it was true that the mixing and application of asphalt were trade secrets, only known to and jealously guarded by those in the business, and as to whether the machinery and sources of supply were controlled by them. An investigation showed that the business was as wide open as that of making bread. There are no patents owned by the asphalt paving companies on the machinery and tools. The sources of asphalt are as wide open as any other material of large consumption; especially since the consolidation of asphalt companies into a trust. They are looking for opportunities to be engaged and the city can have them under very advantageous conditions.

Assuming that the city finds the present method as unsatisfactory as experience has shown it to be, the question of the organization required to permit this work to be done to advantage in the borough of Manhattan has had some attention. For this borough it would not be advantageous to have a single repair plant. The mileage of streets to be taken care of is too great and the distances to be traversed too considerable. Road rollers are uncomfortable vehicles to move for long distances; they travel slowly and are not working to the best advantage when used as locomotives. As it appears to me, there should be at least one station outfit for work below Canal Street; one for the section between Canal and 14th Streets; one for the West Side from 14th to 59th Streets; one for the East Side between the same north and south divisions; one for the section west of Central Park; one for the section east of Central Park, and one for the section above 110th Street. This would make seven stations in all. In addition there would need to be a central station for the preparation and distribution of material. Experience might show that more than one central station is needed, but they could be multiplied as might be found necessary.

The central station should be located on the river front, for economy and convenience in receiving deliveries of materials. Its location might be on either river between 34th and 59th Streets. For a central station the following plant would probably be necessary:

1 mixer for surface material 1 mixer for binder material	$2,500
Boiler, 30 H.-P. engine, accessories and fittings	2,500
Melting tanks, 12 to 15 tons each	2,000
Dryer	6,000
10 wagons, of approved pattern	2,000
25 horses, with harness	6,250
Tools	1,000
Other equipment, not provided for, printed blanks, etc	5,000
Total	$27,250
Or, say	30,000

The plant for each Section Station would be, approximately:

1 steam road roller, 5 to 7 tons	$2,000
Small tools	500
Total	$2,500
For seven stations	$17,500
Total cost of equipment, about	44,750
Or, say	50,000

This will not include land or buildings.

On this basis the annual fixed charges would be:

Interest at 5 per cent	$2,500
Superintendent	3,000
Assistant Superintendent	1,800
Foreman of Central Station	1,200
Foreman of Section Stations (7)	8,400
Total	$16,900

With such an equipment the cost of repair materials should be approximately as follows:

	Per sq. yd. of pavement.
Asphalt cement	30c.
Sand, stone, oil, etc	15c.
Mixing, carting and laying	35c.
Total for asphalt pavement laid	80c. per sq. yd.

All old material taken up in repairing pavements could be taken back by the carts to the Central Station. It would be useful in connection with new material, and might all be relaid if properly treated. Old material is now the perquisite of the contractor. The utilization of old material might reduce the cost of repairs, including binder, to 50 cents per square yard. The economy by unit of measurement will appear from a comparison of this figure with that which is the basis of the general repair contract.

If the work was done by the city and under capable management, it should be possible to maintain an honest asphalt pavement in perfect repair for a period of fifteen to twenty years at an average cost not exceeding 2 cents per square yard per annum.

From a careful study of the problem, and with some knowledge of the kinds of pavements for which the city has paid full prices and something more, I do not think that the seven Section Stations are too many. When necessary, the movable plant and working force of one section might be shifted to another where it was more needed. The only skilled labor required is that specified. The other labor would be the cheapest the city could employ. Over and above anything which can be secured by contract, I am of the opinion that the saving to the city from making its own repairs would be at least 33½ per cent. As before stated, however, I consider the greatest economy possible in first cost of repairs negligible in comparison with the promptness and thoroughness with which they would be made and the condition in which streets could be maintained. The injury resulting from one neglected hole in an important thoroughfare is of more consequence than the greatest cost of mending two holes as soon as repairs are needed.

I estimate that $100 000 would establish and equip a Central Station and seven Section Stations as described, and meet all the costs of operation for one year. It would be entirely proper to establish such a scale of charges for street opening permits as would represent the cost under the present system of replacing the pavements impaired or destroyed. Such payment would relieve the individual or corporation receiving the permit of any responsibility in connection with "making good." In the case of corporations in a position to give an adequate bond to the city to cover the cost of pavement replacement, an agreement might be made on the basis of a uniform charge per square yard for concrete, binder and wearing surface, payable on demand when the work is done. All that would remain a public charge under this system would be the correction of legitimate wear and tear. I am not in a position to estimate the cost of this on the basis of a general average, for the reason that some of the pavements are fairly good, while others are extremely bad; but I am of the opinion that if the work rendered necessary by corporate intrusions was charged for at the prices now paid the asphalt paving companies, the charges devolving upon the borough would be very small. Indeed, with honest management and good financing, the system might be self-sustaining, in addition to keeping the streets in much better condition than they are now or ever have been under maintenance contracts. When repairs become a municipal responsibility it is fair to assume that corporations going or permitting to be done that which causes damage or deterioration to asphalt pavements will be held much more strictly and intelligently accountable than now. For example, if the presence of a manhole cover caused the asphalt to be cut out on one or both sides of it, the company owning such manhole would be held responsible for such repairs as. in the judgment of the Inspectors of the Department of Public Works, approved by the Commissioner, it makes necessary. This would insure repayment for a great deal of the expense incurred by the borough in general street repairs. If a spot of local deterioration is found which is shown to be due to a gas leak under it, the gas company will be held responsible for such deterioration, required to correct the leak forthwith, and pay the resulting costs for pavement repairs. This would be no hardship. It would be nothing more than a proper assertion of the public right in the protection or replacement of public property. As it is, corporate damage to asphalt pavements is accepted as a matter of course, and if the companies patch the holes they actually make with pick and spade, it is about all that is now expected of them.

Under the plan of organization outlined, the material of prescribed quality would be delivered at the central plant, and, after melting and mixing, loaded into wagons for distribution, all under the direction of the Superintendent, who should be an expert. Cartage for five or six miles is practicable. The outfits of the Section Stations would be in use all the time, moving up one street and down another, preceded by gangs of laborers to pick out defective places and prepare them for mending, and followed by wagons to take up the old material. In this way the largest section of the Borough Subdivision could be gone completely over once every thirty days, or oftener, and the asphalt pavements kept in the most perfect condition possible, considering the number of permits necessarily issued for street excavations. Emergency repairs could be made from day to day, and only the results of legitimate wear be left for routine attention. The most economical way to keep the streets of a city in good condition is to repair them immediately when needed. This never has been done, and never will be done under any contract system which human ingenuity can devise.

I am of the opinion that the ideal form of Central Plant would not be a building on a lot of ground on the river front, but a barge of adequate proportions, which would receive its material more cheaply and deliver it on the piers. I believe that the interest on such a floating plant would be less than the cost of ground and interest on the land required.

DISCUSSION.

Mr. Olney.—I am unable to properly discuss the paper of Dr. Bayles without preparation, as it came unexpectedly upon me. The question regarding a municipal plant was discussed in our Department by the President, by the Commissioner of Public Works and myself. I was opposed to it for the reason I thought it more expensive for the city to lay asphalt pavement than it was for a contractor. inasmuch as the asphalt pavement that we have laid during the past year has in some instances been laid for a price of $1.15 complete, the wearing surface, binder and the stone blocks relaid, and if we could establish a municipal plant and put on a force of men such as would naturally be employed by the city, or such as we have now employed by the city. that pavement would cost the city $4 per sq. yd.; and the asphalt companies now doing such repaving guarantee the pavement for five years. Under the repair contract which we have this year we have made our repairs calling for wearing surface and binder for $1.52 per sq. yd., and for wearing surface alone 45 cents per sq. yd., and I doubt if we could expect that any of our street gangs could make the necessary repairs at any such price as that. I have been watching a piece of pavement—stone block pavement—being repaired by a gang of street men. Last week they laid a piece 30 ft. wide by 18; four men engaged the whole week. Foreman, $4 a day, and laborers, $2 a day, while under contract we get granite block pavement relaid complete for $2.50 per sq. yd. That same gang is working now—commenced on Monday and still working—on the opposite side of this street and already completed, in three days, just about half that area. Three pavers and one foreman. This matter has been discussed very frequently in the office with the Commissioner and myself. He has been very anxious to have this municipal plant created for repaving and repairs, and I rather opposed it. I think some of the suggestions of Dr. Bayles very good and some of them I do not approve of.

Mr. Goodsell.—I want to state that when Mr. North was in our department we laid an experimental section of granite pavement on Sixth Avenue, and it cost us, figuring in the time of the men and the cost of material and all, about $6 per sq. yd. for the stone pavement.

Mr. Tillson.—I very much regret that this subject was not given out before, because it is a very important and very interesting one, and one to which I have given considerable attention, and about which I have a good many figures. I have data as regards repairs of asphalt pavement, and also stone, but I cannot give them and do not hardly dare to approximate offhand because it has been some time since I looked at them, but I will say that, our relaying of stone pavement is not one-half that described by Mr. Olney, and certainly not like one-half of the $6 a yard. We have laid this present year about 1½ miles of granite block pavement on concrete, and while, as I say, I cannot give the cost exactly, it compared, however, very favorably with our contract prices. The most of it was laid with second-hand blocks. On one street, laid with new granite blocks, we paid, if I remember rightly, $55 per 1 000 for the blocks and I am quite sure that the cost per square yard of that street, and it was a railroad street, where the cost always is more, was $3.50 or $3.60 per yd., complete, including excavation, concrete, and the new blocks and the laying. You will think about my saying this that I am also like Dr. Bayles, an after-dinner speaker, as I speak on granite pavements when the subject before us is asphalt, but the question of the municipal plant is very important and I firmly believe that it is practicable to establish a municipal plant. I know it is in Brooklyn and I do not see why it should not be in Manhattan. They will be effective and will be reasonably cheap. I believe with Dr. Bayles that if it does cost as much for the city to do the work as it does to do it under contract, it is better for the city to do it. As things are now, we are practically dependent upon the asphalt companies. We can give an order to have a street paved or repaired, but that does not repair it. If the contractors are busy and they refuse to do it, or neglect it, the only thing we can do is to write another letter. But that does not pave the street. The question of the plant to be required is something, of course, that requires special study and can only be determined upon after that study, when you know exactly what is to be done. I presume that the plant planned by Dr. Bayles was one that would be needed when the present asphalt pavements of Manhattan are out of guarantee; not what is out of guarantee now. Am I right, Doctor?

Author.—Partly so, but they are falling out so rapidly.

Mr. Tillson.—If there are only 250 000 yds. out of guarantee now, I think the establishment of such a plant—the fixed charges—would make a pretty expensive price.

Author.—Yes.

Mr. Tillson.—The question of repairs is very hard to figure on positively for the asphalt material, because you may have a street that is situated a mile from your plant and it may require 1 000 yds. of pavement on it, and you may have another one the same distance from the plant and may require 10 yds., and it will cost you a good deal more to repair that 10 yds. on the one street than it will 1 000 yds. on the other—per unit, of course. In regard to the old materials I do not think I can agree with Dr. Bayles. From the experience I have had and the observations I have made where old material was used,—and I have seen considerable of it,—it has never been found to give good results when the old material was used. Of course, if that old material was taken from cuts on a pavement that had just been laid, then it might possibly be used, but I am speaking on the maintenance of the streets after the guarantees have expired and not in any connection whatever with the new pavement which might be in it when repairing cuts. I cannot give any of the figures that I made myself on the cost of the pavements, although I should judge from memory that they did not vary very much from those of Dr. Bayles, and I quite agree with him that the cost of material, or rather the ability to get the material, the mixing and the machinery, is a simple matter and that no city which went into the question seriously would have any trouble whatever. There has been a Municipal Asphalt Plant in use in the City of Winnipeg for some 5 or 6 years, not for the purpose of repairing, but for laying asphalt pavement. All their asphalt pavements for the last 5 or 6 years have been laid by the city. They have not saved very much over their contract prices, but they think they have saved a little, and they have no trouble in obtaining whatever asphalt they need.

Mr. Thompson.—In the Bronx we have not as yet arrived at a period where we have gotten out of the guarantee term. We have had quite serious trouble at times in getting repairs made, and in getting them made either satisfactorily or within a reasonable time, it depending a good deal upon the asphalt contractors and the work they had elsewhere. We have experienced the same difficulty suggested by Mr. Tillson in attempting to get work done when it should be. We write to the asphalt contractors and order them to make certain repairs. If they are not too busy, they make them reasonably prompt; if they are busy, they make them when they get ready, and if we do not like it we write them again, but we have to wait for the asphalt companies. There is no means of enforcing the prompt repairs that should be made and be made as they ought. In the matter of using old material, the companies have in some cases attempted to do that, and the result has been almost universally unsatisfactory. The material has not been equal to the pavement originally laid, and it shows very conclusively on the street that it is not, so far as we have had experience, satisfactory in that condition. It is difficult to get the same condition and to get the repairs made the same, but our experience up to the present time has not been sufficiently extensive to warrant any determination of the value.

Mr. Hillyer.—We have not got beyond the guarantee period in Richmond.

A Member.—Has Dr. Bayles made any investigations as to what damaged streets cost the city in suits?

AUTHOR.—I have not made any such computation and have no data from which to do it.

MR. LACHICOTTE.—As a general proposition asphalt is not a very desirable paving for bridges because of the difference in the expansion of the steel or under-flooring and the asphalting material, and the difficulty of properly compacting the asphalt on account of the generally springy character of the under-flooring. For these reasons the asphalt covering cracks and separates from the under-flooring on which it is laid, and soon disintegrates altogether. The presence of street railway tracks on bridges greatly adds to the difficulty of maintaining asphalt paving. It is a very desirable paving, of course, on account of its comparative lightness as compared with granite block pavement, but recently there has come upon the market a very desirable paving in the form of wooden blocks, which I think will undoubtedly be universally adopted in preference either to asphalt or granite block for bridges. It is preferable to the granite block because of its lightness, and preferable to the asphalt because of its giving a better footing on grades.

MR. BRUSH.—There is one thing in the paper to which I think engineers may well pay attention and that is the refilling of openings. There is very little attention, as a rule, given to the trench after the pipe or gallery is placed, in the refilling, and I think a great deal of settlement could be prevented if more attention was paid by the engineers and their inspectors in requiring a more careful ramming in the back-filling. If you make the contractors back-fill a trench and tamp it in such a manner that the settlement is practically nothing, they consider, especially in laying water-pipe, that you are requiring more than is called for under city contracts. After the contractors have laid the pipe and have carefully rammed the material under the same and up to the middle of the pipe, they consider they should be allowed to put in the material with comparatively few rammers to the laborers filling. I know of one case where we have made a trench 20 ft. or more in depth and where a great deal of attention was given to the back-filling. The contractor filled in to within an couple of inches of the street surface, expecting the settlement to be sufficient to allow him to replace the pavement. He has found since then, to his surprise, that he will have to remove all the allowance that he made for shrinkage. I think in a great many of the works, especially that done by contractors or private corporations, that there will be considerable settlement in the trench lines which show up on the pavement after the asphalt has been replaced.

MR. GOODSELL.—I want to state that most of the asphalt companies now require a guarantee from corporations for repairs made over openings, that is, if the trench shrinks. If there is a depression there they are to repair it and the corporation is to pay for it. The companies are putting that clause in almost all their repair contracts now.

Mr. **Farrell.**—I know Dr. Bayles must have thought of the street kept so nice in England how that would work in New York. The influence that is continually brought to bear to keep contractors going, in business, in the city, when they get a contract, the force and power that they use to do the work as soon as they please, and when they please, are very important points. But there are cases where they fight off doing work to any degree for which they contracted for. I have had some experience in asphalt covering, etc. I find one thing about contractors as has already been stated and that is that the companies are very slow to make repairs. Usually, they wait until the necessity for repairs grow, so that they will have some fire burned repairs to make at the same time, so as to make the work fairly good on the street. That is sometimes the reason. And then, as the Doctor says, some of the repairs are disgraceful. They leave the edges of the repairs in a depressed form, in such a way as to leave it surrounded by water when it rains, and it is very hard to get them to go back and do it over again. They won't do it. That is one great trouble in repairs. They raise the centre too high and leave the sides low. It does not conform to the uniform surface of the street, and by that means is a great cause of wearing out the repair in a short time, but it does seem to me that New York will have to change wonderfully before we can reach any such happy time when we will keep the streets in the city in proper repairs.

A **Member.**—It appears that the question has been discussed from a right point of view only by Mr. Bayles and by Mr. Olney. The remark made by Mr. Olney reflects somewhat on the city's service. If the work done by the city is dear or extravagant as compared with contractors, then it appears to me that many of the city's works would be better if done by outside contractors and not by the city itself. The figures given by Mr. Bayles prove that the repairs can be done at a price of 80 cents per yard, and Mr. Olney claims that the price is $1.16. Even if it cost the city as much as the contractors charge, the city should go into the business, because the work could be done quicker in that way. I am in favor of municipal control of all the work and I would like to know whether Dr. Bayles can say why, if the city is going to establish a plant for repairs, it should not establish a plant for doing all the work and take it out of the hands of the contractors.

Mr. Geo. F. Sever.—This paper of Dr. Bayles on asphalt is certainly very interesting, but I must admit that I was one of those who came here to discuss the other proposition, but yet have been greatly benefited and have learned a great deal about asphalt. I am not prepared to discuss the municipal plant for making asphalt or laying it. I happen to have the honor of being connected with Commissioner Monroe's Department, which has a proposition to establish a municipal lighting plant, of which probably many of you have heard. We have not got it yet and although many arguments were used in favor of it, the city authorities seemed to have looked upon it rather unfavorably. Whether a municipal asphalt proposition will meet with the same fate I am not prepared to say. I trust that the Society will not neglect to ask Dr. Bayles to present a paper upon the advisability of establishing a bureau for tests for this city, if I may speak on that just a moment. I think it is a very important matter to establish for all departments of the city municipal plants, for analysis of asphalt, for instance, speaking more directly to the subject, and testing of asphalts and testing of all other materials which are used in constructing buildings in the city, construction of bridges and the construction of all municipal undertakings. I have the honor of being connected with Columbia University and have, through the influence of Commissioner Monroe, established there electrical laboratories for testing electrical apparatus for the city. Any department may send in materials which they desire to have tested to Columbia for our test and it has proved a great benefit in a number of cases during the time this arrangement has existed. I think this subject ought to be brought up at an early date and thoroughly discussed and means taken to organize some such testing bureau.

Mr. Lewis.—Dr. Bayles spoke of the apparent indifference or aversion of Brooklyn authorities to following up the trail which was unearthed when his tests demonstrated that escaping gas was doing serious damage to the asphalt pavements. I want to say, however, that the recommendation was earnestly made that the matter be taken into the Courts and that quickly, but you know that legal proceedings, especially when a powerful corporation is the defendant, are proverbially slow. Reference has been made to the damage caused by fires. That is, of course, one of the things that the contractor is not responsible for. Fires are fatal to an asphalt pavement, and we know the immense damage caused by them every year, especially on election night. The difference in the cost of repairing such damage in the boroughs of Manhattan and Brooklyn is rather startling. Several years ago I was asked to give the amount which Brooklyn had paid for this purpose during the previous twelve months, and found that it had been $17.50.—I think that was the amount, but am positive it is approximately correct. During the same period Manhattan had paid some $30 000. This is a very remarkable difference. Perhaps Brooklyn people are supposed to go to bed as soon as it is dark, and fires are not attractive in the day time.

Mr. Tillson.—This year it has not been a half dollar.

Mr. Olney.—I wish to say that the cost in Manhattan last year was

$28 000, and do not know how much it will cost this year. Police Commissioner Greene notified every Captain in the Borough to keep watch and prevent any fires, if possible, and yet we have had a list come in so that I think it will be $20 000 this year.

Mr. Lewis.—One cannot but wonder whether these are all burns or whether the bad places were carefully held over until after election, and then all grouped together as fire burns, to be repaired at the expense of the city to the substantial relief of the contractor.

Mr. Olney.—I refer you to Mr. Farrell, an expert on the business.

Mr. Farrell.—I wish to say that whenever I look after fire burns they are fire burns or they don't go down as such, and I know the difference very well.

Mr. Goodsell.—I desire to ask Dr. Bayles if he has ever investigated the effect of oil on the asphalt pavements. It seems to me that this is a matter that is in time going to be important. The automobiles traveling over the streets drop a great deal of oil, and I think it has been generally found to be destructive. I know where trucks having tanks containing kerosene oil—where these tanks leaked over the pavement—that it does affect the surface, and that thing seems to be on the increase.

Author.—As far as that is concerned, I think it depends on what kind of oil is referred to. Petroleum oils would have a very much more energetic solvent action on the asphalt than heavier oils, and some oils I think would be quite objectionable, but where more or less oil is used in mixing asphalt it is not so violent as to merit the cause of any concern to the public in pavement deterioration.

I do not recall, Mr. Chairman, that any other specific questions have remained unanswered, except one, which has slipped my mind for the moment. I will say, however, that this paper which I have had the pleasure of reading is but a fragment of the investigation. Many of the questions which have been asked would have been answered if I had time for the full subject. The results of the entire investigation have been communicated to the Commissioner of Public Works and will very soon appear in printed form, not in the shape in which you have heard it, but under a very much more systematic form, and if it has caused the interest which the suggestions seem to indicate, I cannot do better than to refer those to the report which will be printed. I am gratified with the tone of discussion. I appreciate the fact, especially since the members came to hear something different. If, however, the subject of the Municipal Bureau for tests for standardizing all questions of quality and relative value is of sufficient interest to warrant a very critical and careful investigation, I shall at some future time prepare such a paper.

THE MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK.

Paper No. 6.

THE INVESTIGATION OF NEW SOURCES OF WATER SUPPLY FOR THE CITY OF NEW YORK.

Topical Discussion by
A. S. Tuttle, W. W. Brush and D. D. Jackson, Members
of the Society.

Presented December 23d, 1903.

Mr. Tuttle.—The need of an increase in the water supply of the City of New York was probably first brought forcibly to the attention of the public in 1899, when serious consideration was given to a proposal of the Ramapo Water Company, to furnish the city with a daily supply of 200 000 000 gals. at $70 per million gallons, the water to be delivered at an elevation of 300 ft. into a reservoir to be constructed near the northern boundary of the city. The main source of supply from which this water was to be obtained was the Esopus Creek, the portion of its drainage area to be used being located in the Catskill Mountains.

In favor of the project it was urged that the water was of good quality, that the supply would be needed as soon as it could be made available, and that the finances of the city prohibited it from undertaking the construction. The opposition to even a partial loss of control of the municipal water supply led at once to two investigations of the entire subject, one by Mr. John R. Freeman, on behalf of former Comptroller Bird S. Coler, and the other by an engineering committee of the Merchants Association, of which Mr. Rudolph Hering was a most active member. These investigations included the subjects of waste, need of an additional supply, available sources, cost of construction, and cost of maintenance. The streams considered included the following: Ten Mile River; Housatonic River; Walkill River; Shawangunk Creek; Moodna Creek. Popolopen Creek; Esopus Creek; Schoharie Creek; Catskill Creek; Ramapo River; Delaware River;

Neversink River; Hudson River in the Adirondacks; Hudson River at Poughkeepsie; Peekskill Creek; Clove Brook; Fishkill Creek; Wappinger Creek; Roeliff Jansen's Kill; Kinderhook Creek; and South Branch of the Hoosac River.

Mr. Freeman's studies led him to recommend the Housatonic and Ten Mile Rivers as best adapted to the needs of New York, while the Merchants' Association Committee, following the advice of their counsel, recommended that consideration be given only to the streams having their origin and course wholly within the limits of the State of New York, and on the line of this recommendation they selected the Hudson River as the most available source, the water to be taken either in the Adirondacks or at Poughkeepsie. Filtration was required with the latter scheme, and also with the former if other of the tributaries than Schroon River were to be utilized.

The work of the Commission on Additional Supply, composed of Prof. William H. Burr, Rudolph Hering, and John R. Freeman, which has just made its report to the Commissioner of Water Supply, may be said to be the first complete official investigation which has been made public, although it is generally understood that the engineer corps of the water department has had the situation under consideration for many years, and, although lacking an appropriation of sufficient magnitude to make an exhaustive study, had previously collected such data as could be otherwise obtained. Although the report of the Commission has not been printed, the abstracts published justify us in congratulating them on the thoroughness with which they, in a remarkably short time, have dealt with a question of such magnitude and one which involves so important a factor in the growth and to the prosperity of the city. I believe that we may also congratulate the city upon the personnel of this Commission, and upon having pointed out to it a method to be followed for the development of the supply from which all doubts and uncertainties have been removed.

It is understood that the Commission concurs with all those who have previously studied the needs of the city, in the conclusion that an additional supply is urgently needed, and that works to provide for the same should be begun at once. The published abstracts indicate that, following the advice of the corporation counsel, they have excluded from consideration all streams not wholly within the limits of New York State, and that they recommend the development, first of the Fishkill and Esopus Creeks, with a further extension at a later date, to include the Wappinger Creek, and either the Roeliff Jansen's Kill or Rondout Creek, the latter being preferred on the ground of the softer quality of the water, but not being reported upon in detail at this time owing to the expiration of the time limit placed upon the investigation.

The proposed supply is to be delivered by gravity to a reservoir located near the upper limit of the city, and at an elevation of 300 ft., thus dispensing with all pumping stations either on the watershed or within the Boroughs of Manhattan or the Bronx. Their recommendation also includes not only the filtration of the new supply, but also of that in present use.

The project, in several respects, is similar to that of the Ramapo Company. The estimate of yield, drainage area and storage reservoir capacity provided for each of the streams to be utilized, are shown by the following table, based upon information given in the report of the Commission, to which I have added some data deduced from experience with the Croton River.

TABLE SHOWING THE DRAINAGE AREA, THE STORAGE RESERVOIR CAPACITY, AND THE ESTIMATED YIELD OF THE CROTON SOURCE OF SUPPLY, AND SIMILAR DATA FOR THE ADDITIONAL SOURCES RECOMMENDED BY THE COMMISSION ON ADDITIONAL WATER SUPPLY.

SOURCE OF SUPPLY.	Drainage area—sq. miles.	Estimated daily capacity—million gallons.	Estimated draught on drainage area in inches per annum.	STORAGE PROVIDED.	
				Million Gallons.	Days' Supply.
Croton River................	360	280	16.3	75,000	268
Fishkill River................	81	60	15.6	16,800	280
Esopus Creek................	255	260	21.4	66,500	256
Wappinger Creek............	116	80	14.5	30,500	381
Roeliff Jansen Kill...........	149	100	14.1	17,200	172
Fishkill and Esopus	336	320	20.0	83,900*	262
Fishkill, Esopus, Wappinger and Roeliff Jansen.........	601	500	17.5	133,030*	266

* Includes storage reservoir near Yonkers.

From this table it appears that the storage reservoir capacity to be provided for developing the Fishkill and Esopus Creeks, and later, for the addition of the Wappinger Creek and the Roeliff Jansen's Kill or Rondout Creek, conforms with the Croton precedent. It is also to be noted that with the exception of the Esopus Creek, the draft on the various drainage area is well within safe limits as determined in the Croton valley; from Esopus it is apparently intended to obtain over 30% more per square mile than from the Croton. The character of the Esopus drainage area is not well known to me, but my impression is that in general it is more mountainous than the Croton, which should result in a comparatively greater flood flow and a lesser yield per square mile during the dry season. These conditions would indicate that the Commission has ascertained that there is here a greater or more evenly distributed rainfall than in the Croton. Following the general laws governing rainfall, it would appear probable that, owing to its greater distance from the coast the rainfall in the Esopus section would be less than in the Croton, while, from its relatively higher elevation, the precipitation should be greater.

The lines showing a decrease of normal chlorine in surface water in a northwesterly direction, as ascertained for New York State by Mr. Jackson, appear in general to follow those marking decreases in rainfall, although the relative rate of decrease is much more rapid in the chlorine than in the precipitation. It seems to me that some such similarity might reasonably be expected to exist.

Comparing the results of the Federal Census of New York City for 1890 with that for 1900, it appears that the average annual increase in population has been 3.2 per cent. Assuming that this rate of growth will be maintained, that the per capita consumption of water remains constant, that the present daily consumption, including all consumers, is 400 000 000 gals., and that the average capacity of the sources now in use, public and private, is 440 000 000 gals. daily, there will be required in the year 1925 a daily supply of 800 000 000 gals., this practically agrees with the determination of the Commission that the Esopus and Fishkill supplies (320 million gals. daily) added to the present sources, will suffice to that year. Following this rate of growth, the entire 500 000 000 gals. of additional supply reported upon, will be required in 1930, and in 60 years from the present time the daily consumption will have reached 2 500 000 000 gals.

These figures show the gigantic scale under which the situation must be considered, and that such a growth may be realized and is easily within the range of possibility is further evident from the fact that only a little more than one quarter of the city is now supplied with a street system and with a water supply. That the situation will be a serious one when the time comes that this metropolis may require such a supply as I have indicated, is apparent to all familiar with the water resources of the State.

I understand that the report deals extensively with the question of waste of water, and strongly recommends the use of meters. It does not require a keen insight into the future to predict that the day will arrive when the city must abandon the antiquated system now in vogue of charging water consumers on a scale in which the width of a building, number of stories, and number of fixtures are the sole factors. unjustly taxing the small user for the benefit of those who willfully or ignorantly waste water, and placing absolutely no obligation upon a consumer to make proper use of a supply, with the sole exception of advising him of the existence of rules which can, at best, be enforced only in small measure. The injustice of the present system to the metered consumers is evident from the fact that the revenue per million gallons from this source is far in excess of that from the unmetered supply, a showing which does not encourage an increase in their present number except as required in conformity with the rules of the Water Department. That the consumption is needlessly high because of this long established system dating from the first introduction of water and from a time when ample supplies of good quality were abundant, is well recognized; and it must also be recognized that the general public protests against the introduction of meters in their houses on the ground that they do not desire to be limited in any way in their use (or waste) of water.

In this latter connection I wish to call attention to the results of a rule made by the Department of Water Supply nearly two years ago, requiring all hose supplies to be taken through a meter, which regulation was also supplemented by a legislative enactment providing that when meters were used in private houses, the payment should be based on the amount of water actually used, the frontage rate previously established as a minimum charge for such cases being dispensed with. This regulation forced the installation of meters upon those consumers who had located in the suburbs for the purpose of having large open spaces about them, and who depended upon the use of garden hose to maintain the beauty and productiveness of their grounds, and gardens.

I have compiled the records of about two dozen of the meters set during May last under these circumstances, each located on premises occupied by persons well known to me, and believe that the results submitted in the accompanying table, which includes eight typical cases, are of great value as illustrating the actual use of water under proper conditions.

TABLE SHOWING CONSUMPTION OF WATER IN PRIVATE DWELLINGS IN THE BOROUGH OF BROOKLYN DURING 1903, AS DETERMINED BY METER MEASUREMENTS.

No.	No. of 20 x 100' lots occupied by building.	No. of Fixtures.			Duration of record. Days.	Average consumption per day. Gallons.	No. of Occupants.			Average Consumption per Head per Day. Gallons.		Water rate per year at 10 cents per 100 cu. ft. as based on meter record.
		Bath tubs.	Water closets.	Total No. of faucets.			Adults.	Children.	Total.	All consumers.	Children excluded.	
1...	12	1	2	16	151	68.4	3	3	6	11.4	22.8	$3.34
2...	4	1	2	15	220	132.3	5	4	9	14.7	26.5	6.45
3...	4	1	2	10	169	89.0	3	0	3	29.7	29.7	4.34
4...	3	1	1	10	210	89.0	3	0	3	29.7	29.7	4.35
5...	3	2	3	14	203	106.9	3	3	6	17.8	35.6	5.21
6...	10	2	2	15	203	81.1	2	1	3	27.0	40.6	3.96
7...	8	1	2	16	220	313.5	5	0	5	62.7	62.7	15.30
	4	1	2	12	240	227.5	3	0	3	75.8	75.8	11.10
Total..............................						1 107.7	27	11	38	29.1	41.0	$6.76
Total—No. 1 excluded..........						1 039.8	24	8	32	32.5	43.3	7.24

The houses are all three story frame buildings, with front widths ranging from about 25 ft. to about 45 ft., and under the rates previously fixed, garden hose being charged at the rate of $2.50 per lot, the bills formerly ranged from $20 to about $35 per year, and in some cases would have been still higher if charges had been made for all of the lots connected with the premises and actually irrigated. The consumers are, in every case, in comfortable circumstances, and have made no changes in their habits since the meters were installed. A significant fact concerning these cases, is that each is from a section where sewers have not been constructed and where cess-pools serve for house drainage, with the result that leaks in fixtures have always been promptly attended to, and that great care has been taken to guard against leaving faucets running longer than necessary. In every case these consumers had previously lived in well drained sections, where they became fully accustomed to an unrestricted use of water sufficient for every need, and, so far as I have had opportunity to observe, none of the previous habits or customs have been altered, with the sole exception of the guard against waste. The records in the cases submitted include the 1903 summer or garden hose season use, but, as the rainfall was well distributed, this use was probably below the normal.

Commenting on this record, it should be noted that consumer No. 1 very largely omits the use of garden hose; for kitchen use he also depends partly upon a cistern, while all other consumers derive their entire supply through the meter. Consumer No. 7 maintains a large garden and keeps a man busy continually in caring for it, this care including much more extensive irrigation than in other cases, and probably much more than is required. Case No. 8 is an excellent comparative illustration of the result of an unintelligent use of water; the household consists of two adults and a servant, both of the former being absent from home at very frequent intervals and for prolonged periods during which the servant is in full charge, this doubtless explaining the greater consumption of water, although the garden use is liberal. These consumers were previously quite unaware of their exceptionally small use of water, and were probably just as strongly opposed to the installation of meters as are those of the other parts of the city. Their first bill for six months' use has been presented to them, and in several instances they believed that an error had been made in their account, but now they have become fully satisfied in the certainty that, without exception, their water bill will be sufficiently diminished during the first year's use of a meter to defray the cost of its installation. With sewers provided it is probable that the vigilance of these consumers in preventing waste would be greatly lessened, but to my mind the record fully establishes that 40 galls. per head per day includes a sufficiently liberal allowance for actual use, leakage from mains and use for business not being included.

If this object lesson could be sufficiently brought home to the residents of New York, if the present charter prohibition against the general introduction of meters in private dwellings were to be removed, and if meters could at once be generally installed, it is very evident that there would be no occasion for anxiety as to the adequacy of the present supply for many years to come. Unfortunately, the prospect of an early realization of these ideal conditions is far from assuring, and even the most optimistic must place present hope in the carrying out of the plans of the Commission, depending upon a gradual enlightenment of the public with a resulting popular demand for the prevention of water waste, which demand the future is certain to bring.

MR. BRUSH.—When the Commission was first appointed, they took up the question of the development of the Long Island supply in relation to the present needs of Brooklyn. Of course it was known from the beginning that the new supply would not be available within the time it would be absolutely needed, or rather, within the time its need would be greatly felt by the city, and so the Commission looked for the additional supply for Brooklyn from a further development of the Long Island water-shed. I presume the majority of you are familiar with the water-shed which we have there, which consists of a sandy plain on the south side of Long Island, the present supply being derived from driven wells and from small surface streams. The stream supply normally is about 65 per cent. and the driven-well supply about 35 per cent. The total supply to Brooklyn in the past year, omitting private plants, amounted to about 105 000 000 gals. a day. The work of the Commission on Long Island was devoted to the investigation of the underground supply, and in carrying out this work they had numerous field parties and have driven a great many wells for the examination of the soil and for the determination of the underground level. In the saturated sands the water level varies comparatively slightly during the year. When we get to within half a mile of tide water, the annual variation in the height of the ground-water level is usually between 3 and 5 ft., and the ground water slopes upward gradually from the sea towards the center of the Island, the slope near the sea being about 7 to 8 ft. to the mile. The Commission's work in determining the underground water level was to get the water level contours for Long Island, running from north to south shore, *i. e.*, from the Sound to the Ocean, and from the western end of the Island to about Riverhead. They made a few observations as far east as Riverhead, but the majority were made in the section which was considered as possibly available for Brooklyn, which extended out beyond Patchogue, but I do not recall the exact distance. The Suffolk County supply is supposedly inaccessible for Brooklyn on account of the law passed in 1896 prohibiting the city from utilizing the surface streams, unless the consent of the Board of Supervisors was obtained. At the time that was considered equivalent to a prohibitory act, and the constitutionality of it has been questioned a number of times, but never in the courts, so that at present we do not know whether the Borough of Brooklyn has the power to utilize the waters of Suffolk County. There may be a possibility of utilizing the underground water, and thus getting a supply without acting contrary to the terms of the Act passed in 1896.

The determination of the water levels by the Commission showed that in the western part of the Island the water divide was a little south of the surface divide after you passed beyond the limits of the borough. Within and immediately east of the borough, the water divide is very nearly at the northern foot of the hill which forms the backbone of the Island; that is to say, on account of the porous character of the soil, the water which falls on the land sloping towards the Sound actually passes into the Ocean on the south side. As we go further east, the line varies in the section which forms what is called the Brooklyn New Watershed, which is the section east of Rockville Centre. The line there is about 2 miles, I think, to the south of the natural divide. When we go into the eastern portion of Suffolk County the water divide runs decidedly to the north of of the surface divide. The cross-section showing the water level from the north to the south shows a very sharp water slope on the north leading down to the Sound and a gradual slope on the south leading down to the bays connected with the Atlantic Ocean. That is due probably to the pressure of the ice sheet consolidating the material on the north shore, and also to the much greater mixture of clay and loam on the north shore than on the south shore. On the north side wells can be driven at almost any point near the shore in the middle section of the Island, and you will obtain practically an artesian well. The friction head in forcing the water through the sand is so great that it will force the water out of the well, rather than through the compact material on the north shore. The practical advantage to be derived from this outlining of the true water-shed would be the determination of the amount of ground water which could be available from any portion of the water-shed, and, of course, having the actual water-shed, instead of what the surface indications would give as the theoretical water-shed, we can tell more definitely the exact amount of surface and ground water which should be obtained from various parts of the Island. The Commission's whole line of work was on the basis of recommending the development of the underground supply, because Long Island, being naturally a suburban residential section for the city, would be settled and developed too rapidly to permit of the surface supply being utilized very much longer without filtration.

Mr. de Varona, Chief Engineer of the Department for the Borough of Brooklyn, previous to the formation of the Commission, or just subsequent to its formation, had made some determinations of the rate of flow through the sand. The Commission also took up and followed out the question of the rate of flow through the sand, and they have made some interesting studies in that connection. The method adopted was one devised by Prof. Slichter, of the U. S. Geological Survey, which consisted in driving wells at short distances apart,—one well up stream, then two just below that, so as to intercept the probable line of flow, and then three or more at a short distance below that, and then dose the upper well with some form of electrolytic, usually sal ammoniac, and connect the upper well with an insulated rod in the lower well and observe the deflection on a voltmeter, or the current shown on an ammeter, and when the electrolytic first struck the lower well there would be an immediate rise in the deflection, as the poles of the batteries were also connected, one to the outside of the well and the other to the rod. The gradual flow of the electrolytic from the upper well to the lower well would be shown by the gradual increase in deflection on the voltmeter, and the time in which it reached the well would be shown by the rapid rise when the poles of the battery were connected to the casing of the well and the insulated rod in the well, the water then becoming charged with electrolytic, and therefore offering much less resistance and showing the greater deflection on the voltmeter. The determinations made by the Department indicated a flow of about 30 ft. to 40 ft. per day through the sand, and in one case the flow was found to be slightly above 100 ft. That seemed to be in a very thin bed of gravel, and 5 ft. below there was no indication of anything more than we find to be the normal,—about 30 to 40 ft. The measurements taken by the Commission were mainly in the vicinity of ponds and showed a very much lower rate of flow. Their flow varied, I think, from 2½ to about 8 or 10 ft. per day, although Prof. Slichter found it in some cases to be equal to that found by the Department.

Determinations were also made of the rate of water passing from the surface down to the saturated bed. In the centre of the Island the saturated bed is from 100 to 120 ft. below the surface and it was found that at a depth of 95 ft. the maximum influence of a heavy storm was felt about five months after the storm occurred. The inhabitants there have stated that the influence of the heavy Fall rains would not be felt for three or four months afterward, but I do not know of any exact determinations made previously. In this case it took about five months for the rainfall to reach the saturated bed 95 ft. below the surface, making the rate of flow about ½ ft. per day.

The Commission recommended that the Department extend the underground system, but I do not think that they recommended any particular form of development. It would rather tax your patience if

I went into the detail of the method recently adopted by the Department for collecting the water by means of infiltration galleries. We have up to the present time utilized the driven wells, both deep and shallow, but the wells have given a good deal of trouble with clogging and consequent expense in maintenance, and also the large expense of maintaining the stations, there being connected with the Brooklyn supply 23 engine houses, forming about 22 separate stations.

In reference to filtration of the Brooklyn supply, the Department has just completed, or has under test, two mechanical filter plants for the surface streams which are nearest the city. The one, which lies south of Jamaica is the largest stream on the old watershed east of Hempstead Valley, and has an average daily flow of about 5 000 000 gals. and will be filtered by mechanical filters. The next stream to the east, where the flow is about 2 500 000 gals. a day, will also be filtered with mechanical filters. Provision has been made for two filters of the slow sand type for two of the streams further east. In this case the Department has utilized the underground water level to prevent the loss of the filtered water, and thus do away with the cost of masonry construction. The under-drains are laid just below the normal ground water level and the beds are then constructed without any attempt to make particularly water-tight banks, and thus saves the expense for any lining or embankment. In this manner the supply will be one of the naturally filtered underground water, which will pass into the drains together, with the surface filtered water. One of these beds has just been completed and will probably be put in operation within a month. The other plant is in course of construction and probably will be put in operation in the Spring. In one case the sand was used without any washing, as the area which could be utilized was large and the flow to be filtered was small. The beds were not underlaid with gravel, simply having gravel surrounding the underdrains. In the other case, the site of the bed is to be excavated, a layer of gravel placed beneath the entire bed and the drains surrounded with gravel in the usual manner, and the sand is to be washed. It is expected that the contractor will have no difficulty in washing the sand which is excavated from the site of the beds. The excavation allows for a large wastage and it is expected that the cost of the sand will only be the cost of washing.

I think I have covered, as far as I know, the work done on Long Island by the Additional Supply Commission. The work which was done up the State, which was very varied and covered an extremely large area, both in ground covered and methods used, analyses of water, mode of observations, and surveys made, is probably better known to some of the other gentlemen here than it is to myself.

The President.—Long Island presents some of the most interesting problems in water supply which can be found anywhere in this country.

The system is known all over the world. It has had connected with it some very famous men, such men as James P. Kirkwood, Moses Lane, Julius W. Adams, with McAlpin and Worthen as consulting engineers. Some remarkable things can be found along the Brooklyn watershed. Some of you may have seen in the neighborhood of a little place known as Millburn, a reservoir designed to hold some hundreds of millions of gallons (500 000 000?), I think, which has been completed for eight or ten years. It had water in it once for a few days, but there was such a flooding of the surrounding country that they have not dared to fill it since. The last I heard of the Millburn Reservoir was when an old acquaintance of mine called on me to ask if I did not think I had enough influence with the city officials to secure from them a permit to use it as a baseball ground. He at that time was manager of the Baldwins baseball nine. But I had not the courage to endorse his application.

In a recent conversation with Mr. Birdsall, he told me of an interview at which were present Mr. Kirkwood, Mr. Lane, Mr. McAlpin and Mr. Francis of Lowell, during which Mr. Adams had used an expression then which he had always remembered. They were discussing the capability of very fine sand, to resist the flow of water through it. Mr. Adams described this as "the fatigue of water," meaning, I presume, that the water had so many obstacles to encounter that it became tired and could get no further.

Mr. Jackson.—There is little occasion for a discussion of the sanitary significance of normal chlorine determinations, as it is already well understood by engineers and sanitarians who have to do with problems relating to water supply. It is well known that normal, unpolluted waters which are near the sea are high in chlorine (common salt) contents, and that the salt found gradually decreases as waters more and more remote from the sea-coast are examined.

If, then, we draw lines connecting regions having an equal amount of common salt in the water, we shall find that in a general way these lines follow the coast, and increasingly diverge from each other as we go inland. A map so drawn containing these lines of equal chlorine (isochlors) will immediately show, within the area covered, how much salt may be found in a normal, unpolluted water from any particular district. By a comparison of the salt contents of any water under examination with that to be expected from the figures for normal chlorine for that region, the excess of salt present over the normal is determined. In sea-coast States this excess of salt only rarely comes from mineral deposits, but is almost invariably due to previous contamination from house or barn drainage. This is brought about by the well-known fact that, in all animal economy a certain amount of common salt is absorbed and later expelled. While this salt plays an important rôle in the blood, in the formation of gastric juice, and in many other physiological processes, it is unlike all other important elements in that it is practically all expelled from the body in exactly the same state in which it is absorbed.

This salt, which is so soluble in water, forms a part of the drainage of the region in which it is expelled, and must eventually become mixed with the general run-off for that region. The average amount of salt entering the drainage of any particular district is so constant for each inhabitant that it has even been claimed that the number of people living on a drainage area may be very closely estimated from the average run-off and the excess of chlorine over the normal.

New York produces more salt than any other State in the Union, and it would be natural to suppose that these salt deposits would interfere materially with the estimation of pollution. Such, however, has not been found to be the case. The salt beds are pockets which have only a local influence, and normal waters may be found within a very narrow range of these deposits. This, unfortunately, does not hold true in States further inland, where the natural salt in the soil has had less opportunity to be washed into the sea. In the inland States these pockets are apparently of so wide an area, and exert so broad and variable an influence, that the determination of chlorine, except in special cases, is practically valueless for sanitary purposes. In such States no chlorine maps are possible, and the normal chlorine is of necessity practically zero. Artificial normals for any lake or stream may, however, be used to advantage in determining pollution, as, for instance, the determination of the amount of chlorine added to a river by any particular city on its banks. The difference between the chlorine in the river above and below the city gives valuable data as to the extent of contamination brought about by the city drainage.

In an estimate of the extent of pollution in a water there is one important point which must be noted. While the water may contain a considerable amount of salt due to pollution, the dangerous elements of this pollution may have been entirely removed, and it is necessary to bring to bear various other chemical as well as biological data in making a proper judgment as to the value of the water for drinking purposes.

To properly draw the isochlors for any State, it is necessary to first obtain a large number of analyses for chlorine in waters taken at different seasons over the entire area to be covered. The largest amount of data is required near the sea coast, where the variations in a limited area are greatest. The presence of mountains or of islands near the coast have a tendency to deflect the isochlors toward the sea. Areas exposed to the prevailing winds from the ocean receive a proportionately larger amount of salt, and the isochlors are deflected away from the coast. The natural conclusion from these observations is that the lower layers of the atmosphere from which the moisture is more easily precipitated contain by far the greater portion of the salt.

The normal chlorine map of New York State, which accompanies this article, is the result of analyses made over a period of six years, and represents the ideas drawn from several thousand samples of water. The largest number of samples were examined on Long Island, Staten Island, and near the coast on the mainland, where the differences of chlorine were greatest over a limited area.

The isochlors for Vermont were drawn from figures kindly submitted by Mr. C. P. Moat, Chemist of the Vermont State Board of Health. The Massachusetts lines are only slightly changed from those published in the Report on the Examination of Water Supplies, Massachusetts State Board of Health, 1890. The Connecticut lines are practically the same as those published in the 1902 Report of the Connecticut State Board of Health, by Dr. Herbert E. Smith, Chemist for the Board, and Dr. Frederick S. Hollis.

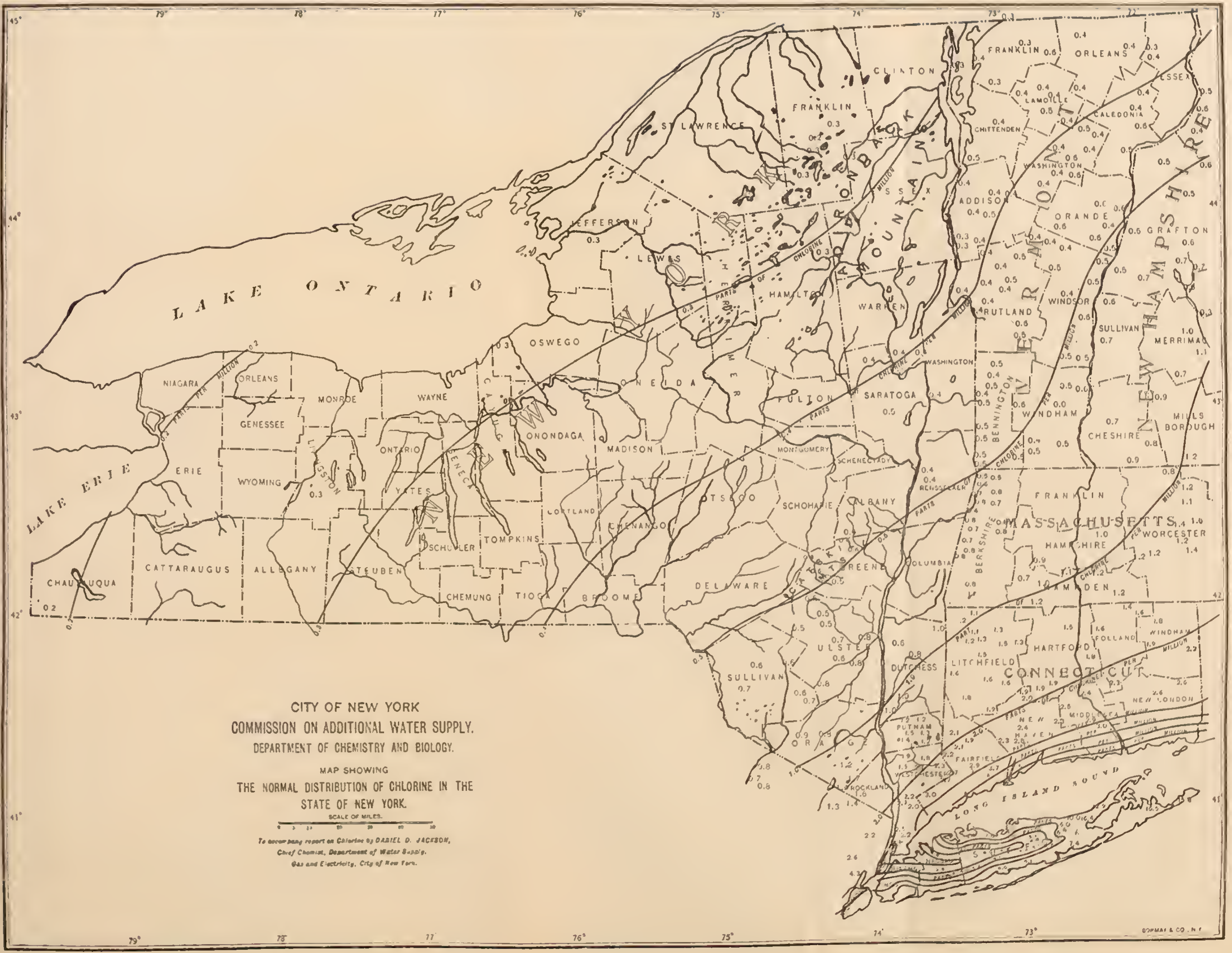
The four, five and six lines which have been added to the Connecticut map are partially from data recently submitted by Dr. Smith. Valuable figures and suggestions have also been received from Dr. H. E. Barnard, Chemist of the New Hampshire State Board of Health. Some figures obtained by Dr. W. S. Myers, of the New Jersey Geological Survey, have also been used to advantage.

It will be seen that the Catskill and Adirondack Mountains cause deflections in the isochlors towards the coast, due to the precipitation on their southern slopes of the rains in the lower layers of the atmosphere.

It will also be noted that Long Island has a remarkable effect in lowering the chlorine on the mainland. The lowest isochlor on the mainland is 3.0 parts per million, whereas if it were not for the protecting influence of the Island it would undoubtedly be 6.0 parts per million. Artesian wells in Manhattan Borough have been found which have a chlorine content of as low as 2.0 parts per million, but these may be considered to be below normal and to consist of water from some distance north of the point from which they are drawn.

The following is a list of some of the waters which have had an influence upon the establishment of the isochlors for New York State:

Name.		Chlorine—Parts per million.
Saranac Lake Village	Saranac Lake	0.3
" " "	Saranac River	0 3
Kashaqua	Kashaqua Lake	0.3
Oswego	McKenzie's Pond	0.3
"	Silver Lake	0 3
Watertown	Water Supply	0.3
Sonyea	Spring	0 3



CITY OF NEW YORK
COMMISSION ON ADDITIONAL WATER SUPPLY.
DEPARTMENT OF CHEMISTRY AND BIOLOGY.

MAP SHOWING
THE NORMAL DISTRIBUTION OF CHLORINE IN THE
STATE OF NEW YORK.

SCALE OF MILES.

To accompany report on Chlorine by DANIEL D. JACKSON,
Chief Chemist, Department of Water Supply,
Gas and Electricity, City of New York.

Name.		Chlorine—Parts per million.
Glens Falls	Hudson River	0.4
Grand Hotel Station	Ulster Co.	0.4
Troy	Lake Ida	0.4
Ashland	Batavia Kill	0.4
Oak	Catskill Creek	0.4
Cooksburg	“ “	0.4
East Durham	“ “	0.5
Shokan	Esopus Creek	0.5
Hasbrouck	Neversink River	0.6
Glen North of Rifton	Black Creek	0.6
Prattsville	Schoharie Creek	0.6
Clinton Hollow	Little Wappinger Creek	0.6
Liberty, Sullivan Co.	Spring No. 1	0.6
“ “ “	“ No. 2	0.7
“ “ “	“ No. 3	0.6
Kingston	Esopus Creek	0.8
Randall Bridge	Rondout Creek	0.8
Middleton	Mohegan Lake	0.9
“	Highland “	1.0
Millerton	Webotuck Creek	1.0
Fishkill	Whalen Pond	1.0
“	Sprout “	1.0
Boyd's Corner Reservoir	Cold Spring Brook	1.0
“ “ “		1.2
White Lake		1.2
East Branch Reservoir		1.3
“ “ “	Tonetta Brook	1.3
Middle Branch “		1.4
Sodom Reservoir		1.4
Suffern	Mahwa River	1.4
“	Ramapo “	1.4
Kirk Lake		1.4
Lake Gilead		1.4
Hillburn	Ramapo River	1.4
Muscoot Reservoir		1.5
Croton Lake		1.5
Tuxedo Park	Spring	1.7
Katonah	Cross River	1.8
Williamsbridge	Reservoir	2.2
Kensico Reservoir		2.2
Glen Park Pumping Station		2.2
Rye Pond		2.6
Yonkers	Grassy Sprain Reservoir	2.8
Tarrytown	Spring	2.9

Staten Island Waters.

Name.		Chlorine—Parts per million.
Stapleton	Water Supply	6.0
Clifton	" "	6.0
Tottenville	Water Tap	6.0
Richmond Turnpike Station	Crystal Water Supply Co	6.2

Long Island Waters.

Hempstead	Well, 1½ miles N. E.	3.0
"	Stream at Source	3.8
Massapequa	Stream Upper End	4.0
Great River	Connetquot Stream	4.0
Babylon	Stream	4.0
"	" 2 miles North	4.6
"	Waterworks	4.8
"	1½ miles North	4.9
"	Well	5.0
"	Pond	5.1
Central Islip	Well ½ mile North	4.0
Islip	Stellenwerf Stream	4.0
"	Well 1 mile South	4.0
"	Beaver Brook, 1½ mile North	4.1
"	Bayshore Supply	4.4
"	Orowoc Creek	4.4
"	Doxie's Stream	4.4
Patchogue	River	4.0
"	Swan Creek	4.4
"	Water Supply	4.4
"	Pond 2 miles North	4.6
"	Tuttle Creek	5.2
"	Well	6.1
Deer Park	Well 2 miles North	4.2
Mellville Station	Well	4.2
Mellville	Well 1½ miles Southeast	4.7
Smithtown	Stream 1 mile South	4.2
Port Jefferson	Town Water Supply	4.4
Ronkonkoma	Lake 1 mile North	4.4
Sumpawampus Creek		4.6
Brookhaven	Connetquot River	4.6
Roslyn	Nassau Light & Power Co.	4.6
East Meadow Stream	Source	4.8
Manor	Well 1½ miles South	4.9
"	" 1 mile North	6.4
"	Stream	7.6

Name.		Chlorine—Parts per million.
Sayville (tap)	Patchogue Water Supply	5.0
“	Edward's Creek	6.8
East Moriches	Mastic River, ½ mile	5.0
Moriches	Well	7.4
Medford Station	“	5.1
Selden	“ 1½ miles East	5.2
Long Pond	Pond	6.0
Northport	Town Water Supply	6.0
Huntington	“ “ “	6.2
“	Stream 1 mile Southeast	7.0
Greenlawn	Stream	6.7
Kings Park	Stream	7.0
Wading River	Spring	10.0
Mattituck	Pond	12.9
Montauk	Well ½ mile East Station	15.8
Aqueboque	“	16.4
Amagansett	Well near Station	16.5
Sag Harbor	Spring 1½ miles Southeast	17.2
Bridgehampton	Well 1½ miles Southeast of Station.	30.8
Greenport	Well	61.8

There is one point which is sometimes lost sight of in the investigation of water supply and that is the value for industrial purposes. Generally speaking, those streams east of the Hudson are over a bed of limestone and the waters there are quite hard. On the other hand, the Esopus, which is on the west, is a very soft water and a very fine water for industrial purposes, as well as for drinking. One of the reasons why the Hudson River was put third on the scheme in picking out the sources of future supply was on account of the immense amount of clay and suspended matter which at times occurs in the river. It would be at times impossible by sand filtration to remove all of that clay and it would be practically as expensive to filter the Hudson River as to go farther north for a water which needs no filtration.

Mr. Blum.—Have any experiments ever been made on behalf of the city to use salt water instead of fresh water?

The President.—You mean for fire purposes? I don't know as anything has been done. The organization known as the Manufacturers' Association has been hammering away for 3 or 4 years and thought they had pretty nearly accomplished their purpose. In the dry goods district salt water mains were introduced for fire purposes. There has been a good deal of complaint as to the supply over there, and at the recent burning of the Academy of Music the situation was an exceedingly serious one, far more serious than made public.

MR. BRUSH.—A 16-in. main is under contract now for laying from our high service Mt. Prospect Tower, back of the large dry goods stores, then following down to Fulton Street and from the City Hall down to very near the river front, and provision is made for a connection down to the river front, where fire-boats can, in future, connect. The mains will be used, after completion, for an additional service to the Heights District, the boundary of which was immediately adjoining the site of the Academy of Music, and one of the difficulties experienced there was the time required in opening up the high service to give the engines water at the time of the fire. The Academy being on the boundary line between the high and low service, and the mains being small, 6-in. and 8-in., the flow is, of course, exceedingly slight, and several of the engines were without water until the high service was opened. The actual use of salt water for fire purposes is very small.

THE PRESIDENT.—In expressing my regret that Prof. Burr did not appear to give his talk, there is yet one very comforting thought which comes to me, and that is, that, although the paper which was announced has not been presented, it has been possible to secure a very entertaining and interesting discussion. I think it is excellent evidence of the good material there is in this Society, for discussion after all is going to be the best part of our work.

Photogravure [illegible] & Co. N.Y.

N. P. Lewis

ADDRESS

OF

Mr. Nelson P. Lewis, President of the Municipal Engineers of the City of New York.

PRESENTED AT THE ANNUAL MEETING OF THE SOCIETY, JAN. 27TH, 1904.

Article VII of the by-laws of the Municipal Engineers of the City of New York requires the retiring president to make an annual address reviewing the progress of municipal engineering work in New York and the work of the Society.

By your leave I shall reverse the order above given, and first briefly review the development of the Society from its first inception to the present time, at the risk of repeating some of the information more formally laid before you in the annual report of the Board of Directors, which comprises the reports of the officers and committees.

On October 3d, 1902, a few engineers, representing seven of the departments of the city government, met for an informal discussion as to the advisability of attempting the formation of an association or society composed of the engineers in the service of the City of New York.

The result of this conference made it clear that there was a field for such an organization, and those who attended it constituted themselves a committee to interview the engineers of the various branches of the municipal service. A committee on temporary organization composed of 42 engineers representing 14 different branches of the city government issued, on February 16th, 1903, a call for a general meeting of all engineers in the city service. This meeting was held at the house of the American Society of Mechanical Engineers on February 25th, and was attended by about 250 engineers, a number which showed such a widespread interest in the movement that its success was assured. At this meeting a committee was appointed to prepare a form of constitution for the proposed society.

At a special meeting held on April 3d, 1903, this committee presented its draft of a constitution which, after some discussion and amendment, was adopted. The meeting also selected a committee to nominate candidates for permanent officers, and to report such nominations at a meeting to be held on April 22d, as the first regular meeting of the Society under the adopted constitution. A committee was also appointed to secure a paper to be read at that meeting.

From April 23d to the present time, monthly meetings have been held, at which papers have been presented and discussed. At the December meeting the member who was to have presented the paper was prevented from doing so, and as there was a large attendance the situation was an embarrassing one. Nothing, however, has more fully demonstrated the fact that the Society has an excuse for its existence, and that it comprises an abundance of good material, than the fact that without the stimulus of a paper there was a spirited and profitable impromptu discussion of the subject which had been announced. That the social features of the organization are not to be lost sight of, was evidenced by an attendance of 110 at the first annual dinner which was held at the Park Avenue Hotel on January 14th, of the present year.

The total enrolment at the beginning of the year was 346, but some who enrolled have failed to consummate their membership by the payment of dues, and the number of members in good standing at the present time is 306 drawn from 19 different branches of the public service.

The story, as you will see, is a short one, but it is significant and full of promise. It is doubtful if another instance can be found where a professional organization occupying a limited field has in so short a time absorbed as large a proportion of those eligible for membership. It can and will be still further extended, and the prediction is confidently made that it will exert a powerful influence upon the municipal work of the city, and give to its members an excellent return for the time and money which they devote to it.

As to the progress of municipal engineering work in New York City, the purpose of the by-laws can, in this first annual address, be best served by a brief review of the conditions resulting from the consolidation of the different municipalities and communities which went to make up the present City of New York. An endeavor will therefore be made to consider these conditions in their bearing upon the engineering work of the city.

On March 4th, 1897, an act of the Legislature, known as Chapter 378 of the Laws of 1897, was approved by the Governor. This act created one great city out of the territory surrounding the harbor of New York and lying within the limits of New York State, with an area of 327 sq. miles. It comprises what were at the time the two largest cities of the State, one other city, and numerous towns and villages having, in 1900, an aggregate population of some 3½ millions. It included two entire islands which became two boroughs, one containing 22 and the other 57 sq. miles; it took from Long Island 207 sq. miles, out of which were created two additional boroughs, while the fifth borough was made up of 41 sq. miles taken from the mainland of the City of New York. This new city contained approximately one-half the population of the State; it had an area one-sixth that of Rhode Island, and more than one-fourth that of the State of Delaware.

The different divisions—known as boroughs—varied greatly in population, in the value of real estate, in their topography and in the manner of conducting their affairs and in carrying out public improvements. To consolidate these areas by legislative action into a political unit was a comparatively simple matter, but to make them a physical entity was and is a very different and vastly more difficult problem.

Six years have elapsed since the legal consolidation took place. The confusion and perplexities were, during the first year, so great that little was accomplished, but physical consolidation is now in progress and will continue until we have a city as homogeneous as the characteristics of topography and people will permit.

When the Greater New York became a political fact, the one connection between parts of the city separated by natural barriers was the Brooklyn Bridge; those spanning the Harlem are not mentioned, inasmuch as both sides of this stream were already one city. Now a second great bridge is nearing completion and is already in partial use, while two others are under construction. These three bridges with their approaches will doubtless cost fully $60 000 000. Besides this the city has under construction a system of Rapid Transit railroads to cost over $40 000 000, including one tunnel under the East River, another under the Harlem, and a bridge over the latter stream.

In this connection mention should be made of the gigantic enterprises initiated by the transportation companies designed not only to weld the boroughs more firmly together, but to connect them with the outside world. These include two double tube tunnels under the Hudson, one of which is about half completed, and another about to be commenced, a triple tube tunnel under the East River and a modern four-track railroad which is to traverse the borough of Queens and connect it intimately both with the neighboring borough of Brooklyn on the south, and with the mainland borough of the Bronx on the northwest through the medium of a fourth great bridge over the East River. Thus all of the boroughs except Richmond will soon have great highways of transportation connecting them with the neighboring parts of the city. Richmond too will have her turn, and while the latest study for an extension of the municipal rapid transit system did not, as was hoped and expected, include a tunnel under the Narrows, it cannot be long before such a connection will be demanded, and provided, if not by the city, then by some great trunk line which, by the activity of its rivals, will be spurred on to such action.

Mention has thus far been made only of transit facilities between the boroughs, for it will be admitted that this must be the first object attained in realizing the physical consolidation which is the corollary and natural sequence of political unity and without which the latter would be a dismal failure. Each borough has also its own serious transportation problems, the duty of solving which has thus far devolved upon the transit companies now occupying the field and which they have performed with but indifferent success. Sometimes we think they have utterly failed, but in no city of the world is this problem so difficult. The general dissatisfaction may yet result in adding these duties to the many others which the municipal engineers of New York are called upon to assume.

Next to bridges and rapid transit, the department whose engineering work has greatly expanded and has extended over the entire metropolitan district is that of water supply. Manhattan and The Bronx, or the old City of New York, had an extensive and costly gravity system before consolidation. Brooklyn had a system of an entirely different type, every gallon of water being lifted a height of from 170 to 200 ft. before being available for use, but the boroughs of Queens and Richmond were dependent for their supply almost wholly upon private companies. The present policy of the city is to acquire all of the independent companies and to gradually municipalize the entire business of supplying water. While the former systems are necessarily maintained in their integrity, the administration has become centralized, and an extensive and thorough investigation has been made—with which you all are familiar—to develop an additional supply which shall be truly metropolitan.

The water front improvements, which, under the jurisdiction of the Department of Dock and Ferries, were a conspicuous feature of the municipal activities of the former City of New York, have been extended to the new boroughs, and here also the metropolitan idea prevails.

Under the first Greater New York Charter the idea of centralization went much further. The borough presidents had little power, and few and unimportant duties. Control over the mapping of the boroughs, paving of streets and building of sewers, which had always been deemed local matters, were vested in officers whose jurisdiction extended over the entire city. The results were so unsatisfactory that the Charter was amended, giving to each borough president exclusive authority over all this class of work. The topographical, highway and sewer work of each borough is now under the control of engineers reporting directly to the borough president or his representative. In only one of the boroughs, however, is there a strictly engineering organization, with a chief borough engineer to whom all assistants in charge of bureaus make their reports.

This policy has proven much more satisfactory in that the accomplishments have been far greater, though it has the disadvantage that there is not the uniformity of practice and standards for work of the same kind in the different boroughs which is desirable.

As to the topographical work, or the completion of the plan of the city, it has been frequently claimed that there was a distinct loss of efficiency resulting from the amendment to the Charter which took the control of this work from the President of the Board of Public Improvements and vested it in the borough presidents, in that the unity of purpose upon which a successful city plan depends is impossible if each borough president follows his own ideas without regard to those of any of the others. The boroughs in which this work remains to be done are isolated from each other, and there can be no connection between their street systems. The planning may be done with a greater degree of intelligence and skill in one borough than in another, but greater progress has thus far been made than seemed to be possible under the previous organization. There is still an opportunity for excellent work. In a recent report submitted to the Board of Estimate and Apportionment the speaker referred to this subject in language which he takes the liberty to repeat:

"An exceptional opportunity for the establishment of admirable street plans for the boroughs of Queens and Richmond is now presented. Their topography is varied, and there are many attractive natural features which could be availed of in an intelligently planned street system. Good, conscientious work is being done by the topographical bureaus of both these boroughs in preparing detailed street plans for different sections of the territory comprising them, and no reflection upon the quality and intelligence of their work is intended when it is suggested that the most expert advice obtainable be secured to recommend a skeleton system of main thoroughfares for the territory yet unmapped. It would be only a plan for a system of arterial streets which would take advantage of the many natural beauties now existing, preserving and emphasizing them rather than obliterating them by a mechanical, rectangular street plan.

"Such an outline plan would control the detailed plotting, which could be readily adapted to it, and I feel confident that the presidents of these boroughs and their topographical engineers would be greatly relieved, and would find their work progress more satisfactorily if they had the advantage of a well-considered system of governing streets covering the entire territory for which each is responsible.

"There can be no doubt but that the expenditure of a few thousand dollars for such advice would be of incalculable benefit to the entire city. The plans of Manhattan and Brooklyn and The Bronx are so well established that no material change can well be made. The mistakes of the two first named are so generally recognized as to require no comment. Many of them were avoided in The Bronx, but the principal hope for really admirable street plans is now centered in the suburban boroughs, and the time to realize this hope has arrived. Expert advice will be worth far more if obtained in the immediate future than if at a later day, and it is earnestly recommended that the policy above suggested be adopted."

A few of the most conspicuous features of the work of the last two years in the different boroughs will be briefly enumerated:

In Manhattan there were comparatively few of what are generally called local improvements, as that part of the city is almost entirely built up. It may be a matter of some surprise, however, to know that a number of the sewers which have been authorized have been on the lower part of Manhattan Island, and in streets where public sewers have not heretofore existed. There are still many blocks on Broadway where there are no such sewers.

The drainage of the lower part of Manhattan Island, with a marked ridge running approximately along its center, has permitted a comparatively simple and inexpensive drainage plan, and block after block containing buildings from 10 to 20 stories in height secure their drainage through sewers in side streets. A number of these have had to be reconstructed of late, as the demands imposed upon them by the large office buildings have been greater than they could meet.

The most conspicuous improvement which has been undertaken is the extension of Riverside Drive from the end of the present viaduct across the Manhattan Valley to Boulevard Lafayette. This will be the most pretentious boulevard the city has ever attempted, the plans having been prepared for the Borough President by Mr. F. Stewart Williamson, a member of this Society. The speaker has ventured to express the hope that this is only the beginning of the extension of the Riverside Drive and that it will, within a few years, be carried across the Dyckman Street valley and Spuyten Duyvil Creek to the northernmost boundary of the city; while it is not improbable that within the next generation it will be carried beyond the city limits far up the valley of the Hudson.

It may also occasion some surprise to know that the upper end of Manhattan Island has not yet been mapped, the topography of the ground lying between Broadway, or the old Kingsbridge Road, and the Boulevard Lafayette being such as to render a street plan with feasible grades exceedingly difficult. A rectangular system of streets is out of the question, but there are possibilities of a most attractive system of driveways over and around the promontory at the north end of the island known as Inwood.

It is probable that nothing has been done or planned which will be of more substantial benefit to Manhattan Island than the improvement of the Grand Central Terminal of the N. Y. C. & H. R. R. R. Co., by the depression of its tracks south of 56th Street in such a manner as to permit of replacing 11 streets from East 45th Street to East 55th Street, inclusive, between Madison and Lexington Avenues, by means of viaducts with easy grades crossing the railroad tracks and yard. An important precedent has been established in connection with this work, as the railroad company, which has heretofore asked and obtained substantial assistance from the city in making its terminal improvements, is not only to bear the entire expense of remodeling its yard, but is to pay the city the sum of $25 750 annually for using the subsurface of various streets. The only contribution which the city is to make is what is estimated would be the cost of opening and constructing ordinary streets across the yard and the building of a viaduct forming an extension of Park Avenue, between 45th and 49th Streets.

In the Borough of Brooklyn, the building of large sewers to accommodate the suburban wards means a new era in the further development of this borough.

Over $3 000 000 have also been allowed to the President of the Borough of Brooklyn for repaving streets, and while this borough was formerly notorious for its dreary stretches of cobble-stone pavement, it is fast becoming one of the best paved urban districts of the United States.

Owing to the fact that nearly all transportation lines in the Borough of Brooklyn lead to Coney Island, and that a number of these were formerly operated under steam railroad franchises, and some are still so operated, while on others electric trains running at high speed have been substituted, there have been a great many dangerous grade crossings, and a special commission, authorized by Chapter 507 of the Laws of 1903 is now making plans for the elimination of these crossings on the two most important railroads. This work is only in its preliminary stages, as there is a heated controversy between the property owners in the vicinity of the lines and the railroad companies as to whether the tracks shall be elevated or depressed, and the commission has not yet approved of any definite plans.

The removal of steam railroad tracks from the surface of Atlantic Avenue is being pushed with vigor, some miles of the elevated structure already being in use and the tunnel sections being nearly completed.

In the Borough of The Bronx the mapping of the territory east of the Bronx River has been rapidly progressing, a tentative plan having been adopted and the preparation of sectional sheets being under way.

There has again risen during the year the problem of relief to overtaxed sewers in The Bronx, and of the diversion of house sewage from the Bronx River. This beautiful stream, which forms a most important adjunct to the park system of The Bronx, is fast being converted into an open sewer. Towns and cities in Westchester county are contributing generally to this nuisance, and the President of the Borough has asked for an appropriation to meet the expense of an investigation of means to remedy the trouble and avoid further pollution.

This sanitary protection of the Bronx valley received serious consideration before consolidation, a Bronx Valley Sewer Commission having been created by the State Legislature in 1895. This body retained as its engineer, Mr. J. J. R. Croes, Past-President of the American Society of Civil Engineers, and an interesting report was submitted to the Legislature in 1896. Nothing was done, however, towards carrying out the recommendations of the Commission.

Under special authority of the last Legislature, steps have been taken to eliminate the remaining grade crossings along the lines of the Harlem and the New York Central and Hudson River railroads in The Bronx, and detailed plans for this work are now being prepared. There still remain a number of grade crossings along the line of the New York, New Haven and Hartford Railroad, the initiative in the elimination of which the company would gladly have the city take, as, under the State railroad law one-half of the cost of the work would probably have to be assumed by the city or the State or both. The city is, therefore, placed in an awkward predicament, as the improvement is one which should be carried out by the railroad company at its own expense.

In Queens and Richmond the work thus far done has been that of preparation for improvements which are to come in the near future. These two boroughs, having areas respectively of 130 and 57 square miles, and together constituting about 57½% of the entire metropolitan district, are almost entirely rural in their character. To make them a part of the second largest city in the world and to govern them by the same charter law as their older and more populous sister boroughs was a daring experiment. They were not prepared for improvements of the class required by Manhattan, and the property could not endure assessments for such improvements. Their most pressing need was a proper street plan. Such a plan requires an immense amount of preliminary work. The charter directed that the system of triangulation which had been made in The Bronx should be extended over the remainder of the city. Five years after the consolidation act took effect very little had been done to carry out this requirement.

Under the President of the Board of Public Improvements a beginning had been made, but after the division of responsibility between the borough presidents, concerted action became practically impossible. An amendment to the charter was secured last spring authorizing the Board of Estimate and Apportionment to enter into an agreement with the U. S. Coast and Geodetic Survey to assume general charge of the triangulation which should be conducted under the supervision of an officer detailed from the survey for that purpose, his salary to be paid by the Federal government, and his subsistence and traveling expenses by the city, which was also to furnish the necessary assistance and instruments and meet all other expenses. This act became a law on May 7th, and on the following day the agreement was authorized by the Board of Estimate and Apportionment. On May 15th, Mr. A. T. Mosman, who had been detailed for the purpose began his preliminary investigations.

The last season was an especially unfavorable one for work of this kind, owing to atmospheric conditions, but fairly good progress has been made. Seven stations have been occupied, and the present indications are that the work will be exceptionally accurate and valuable. Two tripods and scaffolds have been erected, one on the highest point in the Borough of Queens, and the other on a corresponding elevation in Richmond, the structure in the former case being 68 ft. and in the latter 78 ft. in height. The officers of the U. S. Coast and Geodetic Survey have done more than the agreement calls for, having placed at the city's disposal a 10-in. theodolite and have promised another when a second observing party is organized, all of the necessary heliotropes, and shelter tents for observers. It is now proposed to measure one and possibly two new base lines, one of them being along the Ocean Parkway in the Borough of Brooklyn. The U. S. Bureau of Standards will co-operate in the measurement of these base lines, and an opportunity will probably be afforded for the establishment, by representatives of this bureau, of a standard of measurement in several of the boroughs if desired.

The great problem of providing adequate thoroughfares for the accommodation of the immense traffic of the most populous and congested sections of the city, especially for adequate approaches to the great bridges now under construction, has received careful consideration of late. Much of it has been confined to discussion, but public opinion is being educated to the necessity of a broader and more far-sighted policy than has heretofore prevailed in planning such improvements. The city is undoubtedly becoming metropolitan in its spirit and view point as well as in its size and wealth. It is a significant fact that the most ambitious plans for new transit lines, for tunnels, bridges, boulevards and parks, are no longer received as exhalations of a fevered imagination, but are accepted as reasonable solutions of the actual creation of the greater New York which six years ago was attempted by statute.

In this process of development or evolution the Municipal Engineers of the City of New York are destined to take an increasingly important part and bear a correspondingly increasing responsibility. I venture to express, not only the hope, but the conviction, that they will prove equal to it.

MANHATTAN TOWER FOUNDATION FOR MANHATTAN BRIDGE AT THE FOOT OF PIKE SLIP.

Inspected by the Society, October 10th, 1903.

Description of Work, Prepared by H. A. LaChicotte, Engr. in Charge.

The caisson, which is 144 ft. long by 78 ft. wide and 44½ ft. high, surmounted by a coffer-dam for facilitating the erection of the masonry pier on the caisson, was sunk by the pneumatic process to a depth of 92 ft. below M. H. W. and rests on a bed of gravel and sand about 60 ft. below the bed of the river at the pier, and 26 ft. below the bed of the river at the deepest part in that vicinity.

The pier is built of limestone to a height of 8½ ft. below M. H. W., and from that point upward to the top of the pedestal at elevation + 31.46 of granite facing and limestone backing.

On December 11th, 1902, bids were received for the construction of the Manhattan Tower Foundation, and on the 22d of the month the contract was executed with Mr. John C. Rodgers, the lowest bidder, who also built the Brooklyn tower foundation. By the terms of the contract the caisson was to be sunk to a depth of 79.15 ft. below mean high water, and the tower foundation built, complete, for the sum of $450 000, or if the foundation were carried to —103, the amount to be received was $482 726.56. Unit prices covered the work between —79.15 and —103.

On March 12th, 1903, the contractor began the construction of the caisson by assembling the cutting edge timber on the pontoon, which had been previously built. The same methods of building, launching and towing to place were followed that had been used in the case of the Brooklyn caisson. On May 28th, 1903, the caisson was launched, and on July 27th, in the tow of five tugs, it left the slip at 149th Street. After seven hours the caisson had only reached 97th Street; the tide by this time had turned, and it was decided to tie up for the night. At noon next day the journey was resumed, but when Pike Slip, the site of the pier, was reached, the boats were unable to hold the caisson against the strong ebb tide, and it was carried to the foot of Montague Street, Brooklyn, where it was tied up temporarily. When the tide was once more favorable, another start was made and at 7 P. M. the caisson was tied up at its final location, without farther incident.

Considerable time was required to complete the contractor's plant before work of sinking the caisson could be begun, and it was not until the 11th of August that the first concrete was deposited in the caisson. On August 31st the caisson was grounded. Originally an old pier stood on the site, and when the dredging for the foundation was done, a large amount of rip rap, cribbing and piles was not removed, and it was upon this material that the caisson landed, at a depth of about 40 ft.

Most of this material had to be removed by buckets, which made progress at the start very slow. Air was admitted to the working chamber September 18th, and after a month's work, sand began to appear in the bottom, and nearly all of the coarse material, of which there had been about 7 ft., had been removed. Below this depth the material was principally sand, together with a small percentage of gravel, which, however, increased with the depth. On November 20th the cutting edge had reached elevation —68.50, all the concrete above deck had been added, and the limestone masonry was begun.

By December 1st three courses of limestone had been laid, and the cutting edge was at an elevation of about —76.0. An examination of the bottom made at this time showed sand and gravel, together with a few small boulders. In general, the sand was coarse, clean and sharp, and constituted 70% or 75% of the whole; the gravel was principally fine and varied in size from ¼ to 1½ in. in diameter.

The material was not deemed sufficiently solid to insure against lateral movement and consequent settlement, should the adjoining materials be disturbed at any time in the future. The original borings, and also the soundings made at this time, indicated the same class of material at —79.15, the datum plane, and it was, therefore, decided to continue the excavation at least as deep as on the Brooklyn side, viz., —91.85, and accordingly preparations were made to build up the coffer-dam and add more masonry.

The air pressure has been maintained at about the hydrostatic pressure, or a maximum of 47 lbs. above atmospheric pressure. Few cases of bends have developed, of which two have proved fatal.

On April 9th, 1903, bids were opened for building the masonry pedestals on top of the tower foundations. These consist of four courses of masonry to each pedestal, adding about 11.5 ft. in height to the piers. The top of the pedestals are 31.46 ft. above mean high water. Mr. Rodgers was again the lowest bidder, agreeing to build both pedestals for the sum of $150 000, and on July 9th, 1903, the contract for the work was executed. The Brooklyn pedestal was begun on July 30th, and on October 19th it was completed. About a month of this time was occupied in dressing the top of the pedestal to grade after the stone was set. This was done by means of machines with excellent results.

Nothing can be done toward building the Manhattan pedestal until the completion of the tower foundation.

NEW CROTON DAM.

INSPECTED BY THE SOCIETY, NOVEMBER 21ST, 1903.

Description of Work Prepared by Chas. S. Gowen, Div. Engr.

The New Croton Dam at Cornell Site, which is to form the largest reservoir of the impounding system of the Croton River, was begun in October, 1892. It is located about 3¼ miles above the junction of the Croton with the Hudson, and about 1 mile above Old Quaker Bridge. At the dam location, bed rock (gneiss) crops out at the surface on the north side of the river. The valley here is about 450 ft. wide at level of top of bank on south side of river and the total distance across the valley at Flow Line Elevation 200 is about 1 300 ft. The bed rock cropping out on the north side dips quickly just before reaching the bank to a depth of about 75 ft. below the river bed. At this point, on a line about parallel to and under the river, the rock changes abruptly from gneiss to limestone, with no marked change of surface level. The limestone extends across the valley at about the depth noted above, and then rises gradually on the south side with the earth slope and below it at depths varying from 70 ft. to 20 ft. at the extreme south end of the dam location.

Under the river bed the material above the bed rock is largely sand, gravel and boulders. Approaching the south side of the valley it merges into very compact hardpan and gravel next the rock. The hardpan is surmounted next the surface by a considerable layer of sand at the steep part of the slope. Along this slope at about Elevation 153 runs the Old Croton Aqueduct.

GENERAL FEATURES OF DAM.

The general features of the dam may be noted as follows:

An Overflow on the rocky side hill forming the north slope of the valley.

A Masonry Dam built on bed rock and extending from its junction with the overflow at about the foot of the north slope of the valley, across and well into the south slope where it ends in gate house and core-wall for the embankment.

An Embankment with a core-wall extending to bed rock, from the end of the masonry dam along the south valley slope until Elevation 220 the proposed top of this part of the dam is reached.

The Overflow varies in height from 150 ft. at its junction with the main dam to 10 ft. where it joins the side hill at the upper end. This overflow runs along the side hill and nearly parallel to the slope contours, curving up stream at its junction with the masonry dam. The down-stream face of this overflow is formed in steps. Opposite this down-stream face is a channel, cut into the rock of the side hill, down which the water will pass on its way to the river bed below the dam. This overflow channel is about 50 ft. wide at the upper end and 125 ft. wide next to the main dam. The length of the overflow is nearly 1 000 ft. Elevation of top, 200, except for a length of about 250 ft. next its junction with the main dam, where its elevation is 196.

The Masonry Dam extends from bed rock to Elevation 216 and provision is made for a way on top 18 ft. in width. At the north end near its junction with the overflow is a gate house, of three chambers. Grooves in the masonry of the up-stream face will be provided for stop-planks, and in each chamber will be gates worked from the top of the dam connecting with a 48-in. pipe. The pipes extend through the dam, and at the outer end a vault is planned with stop-cocks to further control the flow through these pipes.

The Masonry Dam will be about 900 ft. in length from its junction with the overflow to the gate house at the south end, and its extreme height is 296 ft. Maximum thickness at bottom next to rock about 216 ft.

The Embankment extending south from the gate house at the end of the masonry dam will have a core-wall extending throughout its length, sunk to bed rock, thus forming with the overflow and main dam a continuous masonry connection with bed rock throughout the whole length. The elevation of the top of the embankment is to be 216. Width at top, 30 ft. Up-stream slope, 2–1 paved; down-stream slope, 2–1.

Provision was made for discontinuing that part of the Old Aqueduct lying between the slope lines of the main dam excavation, and a loop line has been built further into the side hill nearer the extreme south end of the dam. At the junction of this new line of Aqueduct with the core-wall masonry, the second gate above noted has been built for the purpose of connecting the impounded water in the basin with the Old Aqueduct.

Three masonry conduits are to connect the water in the basin directly with one of the four chambers of this gate house. This connection can be controlled directly by stop-planks in iron grooves built into the face of this chamber as well as by a set of iron gates controling the openings between the gate-house chambers.

The chambers of this gate house are drained by a system of 12-in. pipes which connect with each chamber bottom and merge in one pipe which is laid under the invert of that part of the Aqueduct loop lying on the down-stream side of the core-wall. Near the connection of this loop line with the Old Aqueduct, this pipe line diverges enough to come to the surface of the hill side in a few lengths.

The three masonry conduits mentioned above, enter the gate house chamber at elevation 152.7, 169, 185. The conduits will be so arranged at their outer ends as to draw water from the basin above the dam at varying elevations from 100 to 185 and in their location follow the line of the Aqueduct loop until well away from the toe of the embankment to be built above it, when they will diverge towards the slope of the basin and follow it down to the inlet elevation desired.

General Details of Dam.

The hearting of the overflow and masonry dam is in most part built of rubble masonry in mortar, and the core-wall, gate house foundations, side walls of Aqueduct loop, backing of gate house chambers and inlet conduits are also built of rubble masonry. A part of the main dam at the south end not yet built is to be made of concrete and rubble stone in place of the ordinary method of laying rubble stone in mortar. The overflow is faced above its rock foundation with coursed ashlar facing stones cut to specified rises in courses. On the down-stream side the steps are laid with block stone masonry generally heavier in rise and width than the facing stone, and of depth sufficient to bond under the step formed above.

Coping stones of granite dimension stone form the upper courses, over which the water first passes.

The main dam and outer faces of its gate house are faced wherever exposed, with facing stone of the same class as that in the overflow.

The heavy cornice of the main dam is of granite dimension stone.

This is also used for stop-plank grooves, facings for gate openings, etc., in the gate house, while the remainder of the gate house chamber lining is of brick laid in Portland cement.

The Aqueduct gate house is to have its chambers lined with brick in Portland cement, excepting around the gate openings and Aqueduct openings. where in some case cut dimension stone will be used. The upper Aqueduct and inlet openings where stop-plank grooves are to be provided, are to be faced with iron castings joined into the brick work for that purpose. The inlets are to be oval in shape 6 ft. x 10 ft. inside dimensions. The Aqueduct, horse-shoe shape to conform to the old structure. Brick work is used for the inverts, side walls and arches of the Aqueduct and inlets. Both gate houses will have superstructures of the ordinary type containing hoisting apparatus for working the gates.

THE PROTECTIVE WORK.

The great and deep excavation necessary to afford foundations for the masonry dam involved extensive preparations for turning the river channel from its original location to a new channel cut in the rock slope on the north side of the river. This channel cut is about 125 ft. in width in the clear, and is bounded on the south side by a masonry wall, the foundation of which is in rock and which extended about 300 ft. each way from the center of the main dam parallel to the old river channel. At the ends of the wall heavy earth dams were built extending across the old river channel.

The grade of the bottom of this channel cut is about 50 and the cut is wholly in rock for a considerable distance on both sides of the dam line, and its total length is about 1 100 feet. The top of the walls and dams range in grade from 75 at upper wing dam to 73 at lower wing dam. The part of the wall on the dam location was made somewhat heavier in places than the above dimensions call for, as it was regarded as permanent work. The channel cut grade was made about 5 ft. higher than the old river bed opposite, in order to avoid the great amount of rock excavation necessary to get to river bed grade.

The wing dams, which are nearly 30 ft. above the old river bed, are earth dams with a core-wall of two courses of 3-in. tongued and grooved sheeting extending from 3 ft. below the top of the bank to

20 ft. below the original surface. These sheeting courses were thoroughly spiked together and were stiffened by frequent courses of horizontal range timbers, to which they were fastened when they were put in place.

The embankments are 10 ft. wide at the top, with a slope 1½–1 towards the channel, and 2–1 on the back side.

The toes of the slopes on the channel side are formed of heavy cribwork and from 10 to 12 ft. in height, and above this cribwork the slope is paved to the top. The cribwork in both dams is formed of two parallel cribs, each 10 ft. wide, securely joined together and having a space 6 ft. wide between them filled with very compact earthy material. The faces of the 6-ft. trenches, as well as the outer faces of the cribs, are covered with 3-in. tongued and grooved sheeting sunk from 3½ to 10 ft. into the ground below the bottoms of the cribs.

The particular function of these cribs was, to thoroughly protect the embankment toes from the scour possible in great freshets when the depth in the channel might be from 15 to 19 feet.

The total length of the wing dams, including the 600 ft. of river wall, is about 1 600 feet.

ANNUAL DINNER.

The first annual dinner of the Municipal Engineers of the City of New York was held at the Park Avenue Hotel, Thursday evening, January 14th, 1904, about 110 being present.

Mr. Nelson P. Lewis, President, presided, and after welcoming the members and guests, said in part:

A distinguished engineer, while delivering a commencement address to one of the technical schools in the Middle West a few years ago, used language something like this: "I would caution all you young men against entering the field of municipal work. Become a foreman of a grading gang rather than take any job under a city government."

Gentlemen, I protest against such advice as this. There are no more attractive fields open to the engineer to-day than those offered in our great cities. Classes of Municipal Engineering have been established in almost all of our technical schools, and the most interesting, the most absorbing, the most difficult problems which confront us to-day are those relating to the care, comfort, health and happiness of the enormous congregations of people in our great cities. And yet we must admit that there is perhaps some danger to the young man in municipal engineering work. I must confess that I always feel some regret when a young man does his first work in a city office. Unless he be a man of strong character and of an innate industry and ambition, it may be that the comparatively short hours and the facilities which are offered for shirking may be demoralizing. I cannot but believe that a few years of work, such as a man gets on a railroad survey, for instance, and railroad construction, when he gets up early in the morning, eats his breakfast and takes his instruments, with a few biscuits for lunch, comes back at dark for supper—a year or two of that is invaluable, enabling a man to acquire habits of industry which he will never forget. A young man who goes into municipal office, careful that he does not reach the office before 9 o'clock—preferably a quarter after, or half-past—and who performs his work and drops it at 4 o'clock, lest he be late twice the same day, never amounts to anything. To such a man as that I will agree with Professor Waddell, who advised the young engineers to become foremen of a grading gang rather than take a city job. Loyalty to your ideals, loyalty to your work, is essential to your success anywhere. No more so in city work than in other private work, but is essential there.

Mr. Charles H. Haswell, being introduced, spoke, among other things, of his apprenticeship in engineering when he entered the steam-engine shops of James P. Laird in 1828. He stated these shops were then the largest of their kind in the country; that the draughting room was also a storehouse for patterns and moulds, and contained no furniture except an ordinary carpenter's bench.

He described the draughtsman's tools used at that date as consisting only of a drawing board, a common carpenter's two-foot square, a steel pointed scriber and a small smoothing plane; the lines of a drawing being made with the scriber, defined by a pencil and erased by the plane.

He referred to the lack of text books for ready reference, and stated there were only two recognized civil engineers in New York City at that period, Jarvis and Horatio Allen, and no professional architects, all buildings being designed by the carpenters and masons who built them.

Professor William H. Burr said in part: The field of the Municipal Engineer is a far wider one, I think, than many of us suppose. If we stop to consider a moment, it will be obvious that that field is practically co-extensive with the whole field of civil engineering, and by civil engineering I mean all those branches of engineering which are not military or naval. The great public works of a modern city include almost all lines of practice which a civil engineer is called upon to follow—the planning and construction of streets; the great bridges which span our rivers, the designs of which must contemplate, not only the purely structural or engineering features, but also the accommodation of the greatest mass of people that have ever been transported daily in the history of the world, and at the same time must meet those requirements which are found in academies of good taste; the great water-works, which include reservoirs, conduits, masonry structures of the greatest magnitude, and distribution systems extending like the filaments of a cobweb almost throughout the entire city; and now the design and management of great electric works, both for power and light, pumping engines, machinery of all kinds, and, among other things, those great constructions—tunnels, and every form of engineering work, including even railroads. The construction and actual management of all these works come directly under the Municipal Engineer.

Now, the discharge of these duties, which at the present time must be characterized by the greatest degree of skill and efficiency known, carry with them the gravest responsibilities that belong to human action of a material kind. I think it is worth while to consider just what that means. Enormous expenditures of money must be made, for which the engineer is directly responsible. The character of the organizations of the various departments of the City Government will depend much, I might almost say entirely, upon his attitude toward them. We know that the problem of municipal government has not yet been satisfactorily solved. I have, for one, the greatest faith in the administrative capacity and its development in civil engineering, although I am aware that there are members of the profession who do not take that view. I see no reason why the widest fields of administrative activity should not be open to civil engineers. Some of the most successful presidents of railroads have grown up from the engineering department, and the heads of many other great business enterprises have had their educational training and experience in the profession of civil engineering. One of the presidents of the greatest republic in the world, save one, was a civil engineer. And I venture to believe that the solution of a perfect city government, a great city government in modern times, is more likely to be reached through the civil engineers who design and administer to its great public works than from any other quarter. The training and experience of the engineer in all his work makes for truth and efficiency. Deviousness in direct dealing with an engineering problem brings a swift punishment of defeat. One of the greatest fields, and I think perhaps it may be the greatest field, certainly in the line of municipal work, is that uplifting of the administration and city departments by elevating the purposes, purifying and quickening the life of the departments of a great city government by the dignified and professional character of the administrations, which its civil engineers are giving.

Prof. George W. Plympton referred to such changes in professional engineering practice as had come under his observation since he began engineering work in the fifties. At that time there was considerable doubt about the expediency of using iron in place of wood for bridges. It was a common belief that iron deteriorated in use, became brittle and fell to pieces, and even professional engineers felt some doubt about it. There had been no demonstration. It was affirmed that the iron could be made durable, or could be used so that its preservation could be insured. The Niagara Bridge was finished about 1853 or 1854. At the time he began bridge building in 1856, Squire Whipple had built two or three iron bridges, and one very successful one over the Albany and Northern Road above Troy, and it was so notable an event to rely confidently on a bridge which was all of iron that that bridge was visited by engineers from great distances. By the aid of numerous demonstrations, chiefly through the aid of a testing machine built by John W. Murphy, the Murphy-Whipple bridge was built, so called because the Whipple plan was slightly modified. The old Howe Truss Bridge, with its vertical iron rod and timber strut panels were common enough, and as these bridges were removed and put out of use old rods that had been in use for a very long time were obtained, proving upon being pulled apart that they were fibrous iron and had not deteriorated. It took a long time, however, to convince people generally that if iron were used within the limit of its elasticity and subjected to no stress greater than that, it could be safely depended upon. In those days an iron bridge of 250 ft. span was worth going a long way to see. The breaking weight of merchantable iron was about 50 000 lbs. to the square inch, and its elastic limit could be safely put at 24 000 or 25 000 lbs.

Prof. George F. Sever spoke of the duties of the Electrical Engineer in the city as being very numerous, particularly as regards municipal affairs. We have such simple problems as the removal of the west side pole line with the wires strung through the air, the pole line itself being a magnificent engineering construction. The people say, "We want that down." It is up to the Department of Water

Supply, Gas and Electricity to take it down. Mr. Jones, a public-spirited citizen, wonders why it does not come down. Orders have gone forth to remove it. But Mr. Jones little realizes the tremendous problem which the taking down of that line involves. In the first place, telephone currents are transmitted over those lines to Chicago, Omaha, Boston, Springfield, Albany, Buffalo, all long distance lines, and if those wires were put into a cable containing 1 200 wires, perhaps 600 pairs, by the time you reached 145th Street from Cortlandt Street Exchange, a distance of perhaps 10 miles, there would be absolutely no sound. You could not get the telephone current any further. All the energy of that electric circuit would be absorbed either in the installation or in the lead sheet. Through the scientific investigations, and wonderful invention of Prof. Pupin, of Columbia University, the New York Telephone Company has been able to place coils on the cables which they are now laying, and there are to-day eight pair of comparatively successful underground wires from Cortlandt Street through to Boston and Springfield. And if all goes well and all cross-contact on those cables is eliminated, by the middle of February the first axe-cutting will commence. It was hoped that that line would be down by the first of January, but, owing to the numerous delays and difficulties of cross-contact and leakage, the date for taking down that eye-sore has been put off until a few weeks later. But Mr. Jones, the public-spirited citizen, hammers one of our departments because the line does not come down when he wants it. The speaker also referred to the difficult third-rail problem awaiting satisfactory solution, and urged that this society with others should attempt to relieve the public mind as to the operations in engineering fields in this city and to quell those outbursts of sensationalism that produce wrong ideas among the general public.

Mr. F. P. Burt spoke in an interesting manner of the technical press and its relation to engineers and the works of great importance under their charge.

CONSTITUTION, BY-LAWS, LIST OF MEMBERS AND ANNUAL REPORT.

1903.

EDITED BY
WISNER MARTIN, Secretary.

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It was thought advisable to print the Constitution and By-Laws as, undoubtedly, they will be amended September 28, 1904.

CONSTITUTION.

ARTICLE I.—NAME AND OBJECTS.

Section 1.—The name of this Society shall be "The Municipal Engineers of The City of New York."

Sec. 2.—The objects of the Society shall be to further the material development of the City of New York, to elevate the standard of efficiency and harmonize the work of the engineering staffs of the several departments of the public service and to promote the technical, professional and social interests of the engineers in the employ of the city.

ARTICLE II.—MEMBERSHIP.

Section 1.—Any person shall be eligible for membership who for at least six months immediately prior to his application for membership has been an employee of The City of New York and is a civil, mechanical or electrical engineer, architect or chemist, or is an assistant to a civil, mechanical or electrical engineer, architect or chemist, who shall in the judgment of the Board of Directors possess such technical and personal qualifications as to make him a desirable member of the Society.

ARTICLE III.—DUES.

Section 1.—The annual dues for members of the Society shall be ten dollars. All dues shall be payable semi-annually in advance on the first day of January and the first day of July.

Sec. 2.—Any person who shall be elected to membership after the first day of April or October in any year shall pay only one-half of the amount of dues for that half year. *As amended Sep. 28, 1904.*

Sec. 3.—Any person whose dues shall be more than two months in arrears shall be notified by the Secretary; and if such arrears shall continue for thirty days thereafter he shall forfeit his privileges in the Society. Should his dues become one year in arrears he shall again be notified; and if they be not paid within one month thereafter his name shall be dropped from the membership roll of the Society upon a majority vote of the members of the Board of Directors at any meeting of the Board and such action shall be announced at the next regular meeting.

Sec. 4.—The resignation of a member shall not be accepted by the Board unless he has paid his current semi-annual dues. *As amended Sep. 28, 1904.*

ARTICLE IV.—ADMISSION AND EXPULSION.

Section 1.—Any person eligible under the provisions of Article II ma apply for membership in the Society. Such application shall be in writing must be endorsed by at least three members in good standing and shall b in such form as the Board of Directors may prescribe.

Sec. 2.—All applications shall be referred to the Board of Directors wh shall take such action as may be necessary to verify the statements contained in it. If the applicant be found to be eligible he may be elected to membershi by the affirmative vote of two-thirds of the members of the Board of Director confirmed by a two-thirds vote of the members present at the next regula meeting of the Society.

Sec. 3.—Any member who shall be guilty of any act which shall reflect discredit upon the Society may be expelled by a two-thirds vote of the members of the Board of Directors if such action be confirmed in the same manner as is provided for admission.

ARTICLE V.—OFFICERS.

Section 1.—The officers of the Society shall consist of a President, two Vice-Presidents, a Secretary, a Treasurer and fifteen Directors who shall constitute the Board of Directors. At least one and not more than nine of these officers shall be employed in any one Borough. Each Borough shall be represented by at least one resident.

Sec. 2.—The terms of office of the President, Vice-Presidents, Secretary and Treasurer shall be one year and of the Directors three years. Five of the fifteen Directors shall be elected at each annual meeting. The term of each officer shall commence at the close of the annual meeting at which he shall have been elected.

Sec. 3.—In case of a vacancy in the office of President the office shall be filled by the senior Vice-President. A vacancy in the office of Secretary or Treasurer or of a Director shall be filled by the Board of Directors and the person so elected shall hold office until the next annual election.

ARTICLE VI.—DUTIES OF OFFICERS AND MANAGEMENT.

Section 1.—The President shall have general supervision of the affairs of the Society; he shall preside at all meetings of the Society and of the Board of Directors at which he may be present and shall be *ex officio* a member of all committees. He shall be accountable to the Society and to the Board of Directors for the conduct of the affairs of the Society in accordance with the Constitution and By-Laws and the laws under which the Society is organized; and under the direction of the Board of Directors he shall be the chief executive officer of the Society.

Sec. 2.—The First Vice-President or in his absence the Second Vice-President, shall in the absence or incapacity of the President exercise all the authority and perform the duties pertaining to the office of President. The First Vice-President shall be chairman of the Finance Committee and the Second Vice-President chairman of the Membership Committee.

SEC. 3.—The Secretary under the direction of the President and the Board of Directors shall be the executive officer of the Society.

He shall be the custodian of the property of the Society excepting the funds invested or in bank; he shall keep the records of the Society and conduct its correspondence; he shall collect all dues and transmit them to the Treasurer; he shall certify to the correctness of all bills; he shall attend all meetings of the Society and of the Board of Directors and prepare the business for and keep the minutes of such meetings; and he shall perform such other duties pertaining to the business of the Society as may be assigned to him by the President or the Board of Directors.

SEC. 4.—The Treasurer shall have charge of the funds of the Society and shall invest them in such amounts and in such securities as may be ordered from time to time by the Board of Directors.

He shall pay all bills when approved by the Board of Directors and shall render statements of accounts with vouchers for all payments to the Board of Directors at their monthly meetings or at such other times as the Board may direct.

The Treasurer shall give a bond for the proper discharge of the duties of his office in such amount and with such surety as the Board of Directors shall approve and the premium on the bond shall be paid out of the funds of the Society.

SEC. 5.—The management of the affairs of the Society shall be vested in the Board of Directors which shall have complete control of the property and funds of the Society.

SEC. 6.—No contract or obligation whatsoever shall be entered into or incurred by any officer of the Society unless it was previously authorized by the Board of Directors or by a majority vote of the whole Society.

SEC. 7.—The Board of Directors shall pass upon and ratify or disapprove the action of any meeting of the Society in all matters of policy or obligation. In case such action be disapproved it shall be the duty of the Board to submit the matter in the form of a letter ballot to the whole membership of the Society and the action of the meeting shall be held to be ratified and confirmed if a majority of the whole membership vote affirmatively.

SEC. 8.—Within two weeks after the annual meeting of the Society the President shall appoint a Finance Committee, a House Committee, a Membership Committee, and a Publication and Library Committee to which appropriate matters shall be referred for consideration and report to the Board. At least one member of the Board of Directors shall be a member of each of these committees and of any additional committees which may be provided by the By-Laws but the Membership Committee shall be composed wholly of members of the Board of Directors.

ARTICLE VII.—NOMINATIONS AND ELECTIONS.

Section 1.—A Nominating Committee of fifteen members of the Society shall be chosen at the regular meeting in the month of November.

Sec. 2.—This Committee shall be composed of members representing at least eight departments but there shall not be more than two members of the Committee from any one department, the offices of each borough president being considered one department. *As amended Sep. 28, 1904.*

Sec. 3.—The Nominating Committee shall prepare a list of names to be voted upon for the offices provided for in the Constitution and shall report them at the regular December meeting.

Sec. 4.—Additional nominations may be made by any thirty or more members if the nominations are submitted to the Secretary, signed by such members, not more than ten days after the December meeting.

Sec. 5.—At least ten days before the annual meeting, the Secretary shall mail to each member of the Society a printed ballot containing the names of the members selected by the Nominating Committee for each office together with any additional nominations made as provided by Section 4 of this article. These ballots may be sent by mail to the Secretary or handed to him at the annual meeting. They must be enclosed in two sealed envelopes and the outer envelope shall be endorsed by the voter's signature.

Sec. 6.—The ballots shall be counted by three tellers appointed by the President. The member receiving the highest number of votes for the office for which he has been nominated shall be declared elected.

ARTICLE VIII.—MEETINGS.

Section 1.—The Annual Meeting of the Society shall be held on the fourth Wednesday of the year or the nearest practicable day, at the Society meeting room, at which meeting the annual report for the year ending December 31st next preceding, shall be presented and the ballot for officers canvassed. *As amended Sep. 28, 1904.*

At this meeting fifty members shall constitute a quorum.

Sec. 2.—Meetings for the transaction of business, for the reading and discussion of papers and for social intercourse shall be held on the fourth Wednesday of each month or the nearest practicable day, excepting the months of June, July and August. At these meetings twenty members shall constitute a quorum. *As amended Sep. 28, 1904.*

Sec. 3.—Special meetings may be called by the President upon the written request of twenty members and the purpose of the meeting shall be stated in the request. The call for the meeting shall be issued at least one week prior to the holding of the meeting and shall state the purpose of it. No other business than that stated in the call shall be taken up at the meeting. Twenty members shall constitute a quorum for a special meeting.

Sec. 4.—Meetings of the Board of Directors shall be held at least once a month, except June, July and August, at such times as the Board may determine; seven members shall constitute a quorum for a meeting of the Board. *As amended Sep. 28, 1904.*

ARTICLE IX.—BY-LAWS.

Section 1.—The Board of Directors shall frame By-Laws providing for he conduct of meetings of the Society and of the Board of Directors and for uch other routine business as may not be provided for by the Constitution.

Sec. 2.—The By-Laws shall not become operative until they shall have een submitted to the Society and approved by a two-thirds vote of the embers present at any regular meeting.

Sec. 3.—Any of the By-Laws may be suspended at any regular or special eeting by a three-fourths vote of the members present.

ARTICLE X.—AMENDMENTS.

Section 1.—Proposed amendments to the Constitution must be submitted n writing and signed by not less than five members.

Sec. 2.—An amendment may be presented at any regular meeting and if o ordered by a majority of those present it shall be referred to the Board of irectors. The Board shall consider the proposed amendment and re-ort with its recommendations at the next regular meeting. The amend-ent shall be open for discussion at this meeting and may be amended y a majority vote in any manner not inconsistent with the intent of the riginal amendment.

Sec. 3.—If approved as offered or if amended it shall be voted upon by etter ballot, the ballot to be issued at least ten days before the next follow-ng regular meeting at which meeting the vote shall be counted. The ballot hall be accompanied by a copy of the recommendations of the Board of irectors.

Sec. 4.—An affirmative vote of two-thirds of all the ballots cast shall be ecessary for the adoption of any amendment.

Sec. 5.—Upon the recommendation of the Board of Directors the By-Laws ay be amended at any regular meeting by the same vote as that required or their adoption.

Adopted April 3, 1903.

BY-LAWS.

I.—MEETINGS OF THE BOARD OF DIRECTORS.

The Board of Directors shall hold a meeting on the fourth Wednesday of each month or the nearest practicable day, except in June, July and August, and it shall be held prior to the hour fixed for the meeting of the Society if both meetings occur on the same day. The hour and place for all meetings shall be fixed by the President who shall also have the power to call special meetings of the Board whenever he deems them necessary or whenever so requested in writing by six of the Directors. *As amended Sep. 28, 1904.*

II.—MEETINGS OF COMMITTEES.

Meetings of each of the Standing and Special Committees shall be held whenever called by each of the Chairmen of them. Each Committee excepting only the Committees on Nominations and Prizes shall hold at least one meeting during each month except June, July and August.

III.—REPORTS OF COMMITTEES.

Each of the Standing and Special Committees excepting only the Committees on Nominations and Prizes shall make a report to the Board of Directors at each of its meetings including in it a statement of the work accomplished and any recommendations which it deems proper for the upbuilding of the Society. At the January meeting each Committee except the Nominating Committee shall present a report in writing covering its work for the year ending on December 31st preceding. *As amended Sep. 28, 1904.*

IV.—ORDER OF BUSINESS FOR MEETINGS.

1. BOARD MEETINGS.

    I. Roll Call.
    II. Reading of the Minutes.
    III. Report of the Secretary.
    IV. Report of the Treasurer.
    V. Report of the Finance Committee.
    VI. Approval of Bills.
    VII. Report of the Publication and Library Committee.
    VIII. Report of the House Committee.
    IX. Report of the Committee on Inspections.
    X. Report of the Membership Committee.
    XI. Election of Members.

XII. Reports of Special Committees.
XIII. Authorization of Expenditures.
XIV. Announcement of Appointment of Committees by the President.
XV. General Business.
XVI. Adjournment.

As amended Sept. 28, 1904.

2. STATED MEETINGS OF THE SOCIETY.

I. Reading of the Minutes.
II. Announcements by the Secretary.
III. Appointment of Tellers.
IV. Collection of Ballots.
V. Annual Report of Board of Directors (January meeting).
VI. Award of Prizes for Papers (January meeting).
VII. Nominations for Membership of the Nominating Committee (October meeting).
VIII. Election of the Nominating Committee (November meeting).
IX. Report of the House Committee on the Annual Banquet (November meeting).
X. Report of the Nominating Committee (December meeting).
XI. General Business.
XII. Reading of Paper and Discussion.
XIII. Report of Tellers.
XIV. Installation of Officers (January meeting).
XV. Adjournment.

As amended Sep. 28, 1904.

3. SPECIAL MEETINGS OF THE SOCIETY.

I. Reading of the Call for the Meeting.
II. Business for which the Meeting is Called.
III. Adjournment.

V.—REPORT OF THE BOARD OF DIRECTORS.

The Board of Directors shall prepare an annual report to the Society and present it at the January meeting. This report shall show the work done by the Society during the twelve months ending on December 31st preceding and it shall embody the reports of each of the officers and of the chairmen of each of the Standing and Special Committees covering the same term.

VI.—ANNUAL ADDRESS BY THE PRESIDENT.

The retiring President shall make an address reviewing the progress of Municipal Engineering work in New York City and the work of the Society.

VII.—DUTIES OF THE SECRETARY.

The Secretary shall carefully scrutinize all expenditures and use his best endeavor to secure economy in the administration of the Society.

He shall keep an inventory of all of the property of the Society. He shall have charge of the Society's rooms and property and shall supervise and direct the work of all employees of the Society under his jurisdiction.

He shall collect all papers presented to the Society together with the accompanying drawings and illustrations and the discussion and after affording an opportunity to the authors to arrange the material for publication shall transmit it promptly to the Committee on Publication and Library. He shall edit the annual publication of the Society containing the Constitution and By-Laws, list of members and annual report.

At each meeting of the Membership Committee he shall present all applications for membership together with such written information as he shall have received concerning each applicant.

He shall have charge of the books of classified accounts of the Society and shall furnish the Board of Directors at their monthly meeting with a written statement of receipts and expenses for the month, at such meetings he shall also submit a list containing the names of members more than three months in arrears for dues giving in the case of each member the full period covered by his arrears.

His books of accounts shall be open to the examination of the Finance Committee or their representative at all reasonable times.

He shall transmit to the Chairman of the Finance Committee pending bills which have been incurred by the Society with his certification that they are correct.

At the monthly meeting held in January he shall also present a report in writing for the preceding twelve months ending on December 31st showing the total receipts and expenses for the year under each of the various accounts and the cash balance available at the beginning and end of the period. In this report he shall also show the property acquired by the Society during the aforesaid period and the total membership and the changes in it during the year. A copy of the portion of the report showing the financial transactions of the Society shall be delivered to the Chairman of the Finance Committee at least ten days before the date of the January meeting.

VIII.—DUTIES OF THE TREASURER.

The Treasurer is authorized to pay the Secretary, upon his order duly countersigned by the Chairman of the Finance Committee, such sums as may be necessary but not to exceed twenty dollars in any one month for defraying the necessary small expenses of the Society which cannot be otherwise provided for, in each case the requisition shall show the items for which the money is required. He shall also pay monthly the salaries of all regular employees of the Society upon receipt of a pay roll from the Secretary giving the name of the employee and the amount due, the correctness of it being duly certified by the Secretary and the Chairman of the Finance Committee, the former also certifying that the employment of the persons named and the rate of payment has been regularly authorized by the Board of Directors. All other accounts shall be paid by him promptly upon the presentation of the bill and notification by and the certification of the Secretary that it is correct and has been approved by the Board of Directors. Upon payment of a bill or upon making any disbursement authorized by the Constitution or By-Laws he shall notify the Secretary giving the date and amount. He shall keep one set of books showing all of the receipts and disbursements, the date of each, the names of all persons to whom payment is made and the nature of the service or material paid for. All receipts and vouchers for payment shall be retained by the Treasurer and together with his books shall at all reasonable times be subject to the inspection of the Finance Committee or its representative.

He shall present a report in writing at each of the monthly meetings of the Board of Directors giving in it the cash balance at the date of the previous report, the receipts and disbursements since that date and the cash on hand at the date of the meeting. His report shall also show the name of the institution where the balance is deposited.

At the January meeting he shall also present a statement showing the receipts and disbursements for the twelve months preceding January 1st and the balance on hand at the beginning and close of the year. A copy of this report shall be delivered to the Finance Committee at least ten days before the date of the January meeting. The Treasurer shall be placed under a bond of $2,500 to be filed with the Secretary from which he shall be released upon the termination of his term of office after the certification of the Finance Committee to the Board of Directors that his accounts are correct and that all balances have been transferred to his successor. Upon the election of his successor and the receipt of notice from the Secretary that a proper and satisfactory bond has been filed by the new incumbent the outgoing Treasurer shall turn over all of the funds and vouchers of the Society to his successor.

IX.—LIBRARIAN.

The Board of Directors upon the recommendation of the Publication and Library Committee are empowered to elect a Librarian who shall be responsible under the direction of the aforesaid Committee for the collection and proper maintenance of a Library suited to the needs of Municipal Engineers. He shall hold office during the term of the Board which elected him or until his successor is appointed. He shall make a report in writing to the Publication and Library Committee prior to each monthly meeting of the Board of Directors showing the increase in the library during the month immediately preceding and recommending works the purchase or acquisition of which appears desirable. In his report submitted prior to the January meeting he shall show the work accomplished during the preceding year.

X.—FINANCE COMMITTEE.

The Finance Committee shall be composed of five members. It shall have general supervision of the financial affairs of the Society and shall advise the Board of Directors as to the investment of money and the handling of the finances of the Society. It shall examine and submit to the Board of Directors all bills which have been incurred and which have been presented and shall indicate on each its approval or disapproval. It shall examine the books of the Secretary and Treasurer at such times as it may deem proper and upon the approval of the Board of Directors it may employ an expert accountant for this purpose. It shall countersign by one of its members all drafts upon the Treasurer for all petty cash and all pay rolls of the Society.

It shall submit a written report at the January meeting of the Board embodying in it a report upon the accounts of the Secretary and Treasurer for the year ending December 31st immediately preceding. It shall also examine and report to the Board upon the accounts of an outgoing Treasurer before his bond shall be ordered released.

XI.—HOUSE COMMITTEE.

The House Committee shall be composed of five members. It shall be the duty of this Committee under the direction of the Board of Directors to select a proper place for holding the monthly meetings of the Society, to supervise the furnishing of the collations, to promote the sociability of the members and guests attending all meetings and to have charge of the selection and furnishing of the rooms. It shall also provide opportunities for acquaintance and sociability at all times and places within its discretion and power. It shall have charge of the arrangements for an annual banquet and shall report its recommendations for it to the Board at its November meeting, if the Board so directs the Committee shall perfect the arrangements and report upon them in detail to the Secretary at least three weeks prior to the date fixed for the banquet. It shall present an annual report at the January meeting of the Board.

XII.—MEMBERSHIP COMMITTEE.

The Membership Committee shall be composed of five members. It shall carefully consider the qualifications and desirability of all applicants for membership in the Society. It shall make a report at each monthly meeting of the Board of Directors giving the name, title and place of employment of each candidate whose application has been examined, it shall also submit the papers connected with each application and a list of the names of those whom it unanimously recommends for membership. At the January meeting it shall present a report showing the work accomplished during the year. *As amended Sep. 28, 1904.*

XIII.—PUBLICATION AND LIBRARY COMMITTEE.

The Publication and Library Committee shall be composed of six members. In selecting this Committee the President shall name at least three members of the outgoing Committee. It shall be responsible for the presentation of a technical paper at each of the stated meetings of the Society and for the stimulation of the discussion. It shall have charge of the annual publication of the Society containing the annual address of the President, the papers presented during the year and the discussions together with the report upon works visited by the Society during the year. All such papers and reports shall be placed in its custody by the Secretary at as early a date as practicable and they shall be revised and edited for publication.

It shall be empowered to select an Editor and a Business Manager subject to the approval of the Board. All business connected with this publication shall be attended to by this Committee subject to the oversight and direction of the Board of Directors, except that all sales of the publication shall be made by the Secretary. All collections of money made by the Committee shall be transmitted promptly to the Secretary with a statement to show its source and that officer shall thereupon countersign the receipt given for the payment. The Committee shall supervise the Library, shall purchase all books and if a Librarian is elected it shall direct him in his work. It shall transmit to the Board of Directors at its monthly meeting a report concerning the progress of the work entrusted to it and its report submitted at the January meeting shall embody a complete statement of the work done during the year and an account of the money expended and collected by it. *As amended Sep. 28, 1904.*

XIV.—COMMITTEE ON INSPECTIONS.

Whenever so directed by the Board of Directors the President shall appoint a Committee on Inspections whose duty it shall be to arrange for frequent visits of the members of the Society to various municipal and other engineering works in progress within the limits or in the vicinity of the City of New York. This Committee shall be composed of five members of the Society, one from each Borough and shall be empowered to add temporarily to its membership a member of the Society who is connected or familiar with the work to be visited, such temporary member of the Committee to have no voice in its work except in so far as it relates to the special visit for which the appointment was made. The Committee shall advise the Secretary of all visits arranged for and the dates fixed for them and if they be approved by the President, the former officer shall notify the membership at large.

The Committee shall prepare or have prepared a brief account of all works examined and shall transmit it promptly to the Chairman of the Publication and Library Committee for insertion in the annual publication. The Committee shall submit a report at each of the monthly meetings of the Board of Directors and shall make an annual report for presentation at the January meeting.

XV.--COMMITTEE ON PRIZES.

For the purpose of stimulating a healthy rivalry in the preparation of papers and to encourage members to present valuable data to the Society, the Board of Directors shall appropriate annually a sum of not less than twenty-five dollars to be used for the purchase of a prize to be given to the writer of the paper deemed by the Committee on Prizes to be the most meritorious of the year. This prize shall be a pin or pendant of a design approved by the Society or it shall be cash as preferred by the recipient. The Committee on Prizes shall be composed of three members and shall be appointed by the President but no member of this Committee shall be a member of the Committee on Publication and Library. This Committee shall report at the January meeting of the Board of Directors giving the name of the author of the paper presented during the preceding twelve months which it deems to be the most meritorious in promoting engineering knowledge. To the author of this paper the prize fixed by the Board shall at once be paid by the Treasurer and notice of the award shall be presented at the following meeting of the Society and shall likewise be printed in both publications of the Society. This Committee shall also have jurisdiction over the awarding of any other prizes which may be provided. The Committee shall have power to call upon the Publication and Library Committee for all papers submitted to the Society.

XVI.--ELECTION OF NOMINATING COMMITTEE.

Nominations for membership of the Nominating Committee shall be made at the October meeting of the Society and shall consist of the proposal of a name by one member and the seconding of it by another. Further nominations may be made by any five members who shall submit the name of their candidate or candidates to the Secretary in writing duly signed at least a week prior to the date of the November meeting. No other nominations shall be considered. The Secretary shall have a ballot prepared for use at the November meeting, which shall contain the names of all candidates regularly proposed and the name of the Department with which each is connected. In case more than two members from the same Department receive a majority vote, the two having the greatest number of votes shall be declared elected and a new ballot shall at once be ordered and further repeated if necessary, until the Nominating Committee has been selected as provided in the Constitution. Any ballot in favor of more candidates than are to be elected shall be deemed void.

XVII.—ELECTION OF MEMBERS.

With the general notice of each meeting or with any special notice, the Secretary shall submit a list of the names and official titles of all candidates for membership in the Society giving the name of the department and borough, with which each candidate is connected and inviting members to promptly notify the Board of Directors concerning the desirability or otherwise of admitting the candidate to membership. All replies to this notice shall be delivered to the Committee on Membership and shall be considered by it in connection with its examination of the qualifications of the candidate to which the reply relates. *As amended Sep. 28, 1904.*

All elections of members by the Board of Directors shall be by individual ballot and all information furnished to the Board concerning applicants shall be deemed strictly confidential. The name of no candidate shall be considered for election until after five days have elapsed from the date of advising the membership that the name was under consideration by the Board.

The Secretary shall report to the Society at its next meeting the names of all candidates elected by the Board of Directors since the date of the previous meeting of the Society and a ballot shall then be taken to confirm or reject the election. For such an election a blank ballot shall be distributed on which the names of the candidates shall be written and followed by the words "Yes" or "No." In counting ballots all, even though blank, shall be deemed favorable to the candidate except such as bear his name with the word "No" written or printed after it.

The successful candidate for election to membership shall be notified by the Secretary and upon the payment of his dues and the signature of such pledge to uphold the objects of the Society as may be required by the Board of Directors, he shall become a member of the Society.

XVIII.—PUBLICATIONS.

1.—Two publications shall be issued annually and as soon after the annual meeting as may be feasible. One of these shall be designated "The Constitution. By-Laws, List of Members and Annual Report of The Municipal Engineers of The City of New York." The other shall be designated "The Proceedings of The Municipal Engineers of The City of New York."

2.—"The Constitution, By-Laws, List of Members and Annual Report of The Municipal Engineers of The City of New York" shall be edited by the Secretary and shall contain the Constitution and By-Laws, the annual report of the Board of Directors, a list of all officers and committees of the Society during the year of publication and the one immediately preceding, a list of all Past Presidents and the names of all members. It shall contain a list of the technical papers presented during the year and the names of their authors, the papers awarded the Society prizes for the preceding year being indicated. It shall also show the names and locations of the works visited by the Society since the date of the previous publication.

The list of members shall be arranged alphabetically and shall give the full name of the member, his address, title, the names of the department, and borough with which he is connected and the date of his election to membership. *As amended Sep. 28, 1904.*

3.—"The Proceedings of The Municipal Engineers of The City of New York" shall contain the annual address of the President and all of the papers presented at meetings of the Society held during the preceding year together with the discussions. The papers for which prizes were awarded shall be plainly indicated. It shall also contain a list of the officers and committees for the year of publication and for the one immediately preceding. There shall also appear in this volume a description of all of the works visited by the Society during the preceding year.

XIX.—BADGE.

The badge of the Society shall be an enameled gold button, pin or pendant bearing the name of the Society and the Seal of The City of New York or a portion thereof. The detailed design shall be determined by letter ballot of the entire membership upon such forms as may be recommended by the Board of Directors. Badges shall be purchased only through the Secretary and at the price fixed by the Board of Directors and a person severing his connection with the Society shall deliver his badge to the Secretary who will allow him for it its intrinsic value. *As amended Feb. 24, 1904.*

XX.—CERTIFICATE OF MEMBERSHIP.

Upon application by any member to the Secretary and the payment of two dollars, the Society shall issue an engrossed certificate of membership signed by its President and Secretary. This certificate shall give the name of the member, the date of his membership and the date of issue. Any member expelled from the Society shall at once return his certificate to the Secretary.

XXI.—EMPLOYEES.

The Board of Directors shall appoint the employees of the Society and fix the salaries or other compensations of all officers and employees.

XXII.—FORMS.

The Board of Directors shall prescribe and adopt forms for the transaction of all current business of the Society.

Adopted by the Board, July 8, 1903.
Approved by the Society, September 30, 1903.

CERTIFICATE OF INCORPORATION OF THE MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK.

Know all men by these presents, that we, Nelson P. Lewis, Othniel F. Nichols, Samuel C. Thompson, Wisner Martin, Arthur S. Tuttle, C. B. J. Snyder, John C. Wait, Edward A. Miller, George W. Tillson, Frederick Greiffenberg, George S. Rice, Max Raymond, Henry R. Asserson, Bernard M. Wagner, Theodor S. Oxholm, Rudolph Hering, Robert Ridgway, William S. Dalrymple, Robert R. Crowell and Frederick Skene, all citizens of the United States and of the States of New York and New Jersey, being desirous of forming ourselves into a society or club for technical and social purposes, under the provisions of Chapter XLIII of the General Laws or Chapter 559 of the Laws of 1895 of the State of New York and the acts amending the same, do hereby certify as follows:

I.--The name or title by which the society or club into which we desire to form ourselves as aforesaid shall be known in law, shall be "The Municipal Engineers of The City of New York."

II.--The particular business and object of such society or club shall be to further the material development of The City of New York, to elevate the standard of efficiency and harmonize the work of the engineering staffs of the several departments of the public service and to promote the technical, professional and social interests of the engineers in the employ of the City and for that purpose to establish and maintain in The City of New York, for the use of ourselves, our associates and successors, a club house having a library, a reading room and such other appurtenances and belongings as are usual in society and club houses.

III.—The territory in which the society or club shall conduct its operations is within the limits of The City of New York.

IV.—The principal offices shall be located in the Borough of Manhattan of The City of New York. The annual meeting shall be held on the fourth Wednesday of January.

V.—The number of trustees, directors or managers to manage the said society or club house shall be twenty.

VI.—The names and residences of its trustees, directors or managers until its first annual meeting are as follows:

Nelson P. Lewis, 1511 Albemarle Road, Brooklyn.
Othniel F. Nichols, 42 Gates Avenue, Brooklyn.
Samuel C. Thompson, 950 East 160th Street, The Bronx.
Wisner Martin, 57 West 75th Street, Manhattan.
Arthur S. Tuttle, 1050 82d Street, Brooklyn.

C. B. J. Snyder, 317 West 95th Street, Manhattan.
John C. Wait, 356 West 145th Street, Manhattan.
Edward A. Miller, 1227 Tinton Avenue, The Bronx.
George W. Tillson, 93 Lenox Road, Brooklyn.
Frederick Greiffenberg, 222 West 24th Street, Manhattan.
George S. Rice, Audubon Park, Manhattan.
Max Raymond, 504 West 151st Street, Manhattan.
Henry R. Asserson, 961 Bergen Street, Brooklyn.
Bernard M. Wagner, 257 East 12th Street, Manhattan.
Theodor S. Oxholm, West New Brighton, Richmond.
Rudolph Hering, Montclair, New Jersey.
Robert Ridgway, 504 West 143d Street, Manhattan.
William S. Dalrymple, 219 East 60th Street, Manhattan.
Robert R. Crowell, 73 Herriman Avenue, Jamaica, Queens.
Frederick Skene, 411 Lockwood Street, Astoria, Queens.

In witness whereof, we have to this certificate respectively signed our names this twenty-third day of December, one thousand nine hundred and three.

Nelson P. Lewis,
Othniel F. Nichols,
Samuel C. Thompson,
Wisner Martin,
Arthur S. Tuttle
C. B. J. Snyder,
John C. Wait,
Edward A. Miller,
Geo. W. Tillson,
F. Greiffenberg,

George S. Rice,
Max Raymond,
Henry R. Asserson,
Bernard M. Wagner,
Theodor S. Oxholm,
Rudolph Hering,
Robt. Ridgway,
Wm. S. Dalrymple,
Robert R. Crowell,
Frederick Skene.

Here follow the usual acknowledgments.

OFFICERS FOR 1903.

PRESIDENT

NELSON P. LEWIS.

FIRST VICE-PRESIDENT

OTHNIEL F. NICHOLS.

SECOND VICE-PRESIDENT

SAMUEL C. THOMPSON.

SECRETARY

WISNER MARTIN.

TREASURER

ARTHUR S. TUTTLE.

DIRECTORS

Term expires January, 1904.

RUDOLPH HERING, ROBERT RIDGWAY,
WILLIAM S. DALRYMPLE, ROBERT R. CROWELL,
FREDERICK SKENE.

Term expires January, 1905.

GEORGE S. RICE, MAX RAYMOND,
HENRY R. ASSERSON, BERNARD M. WAGNER,
THEODOR S. OXHOLM.

Term expires January, 1906.

C. B. J. SNYDER, JOHN C. WAIT,
EDWARD A. MILLER, GEORGE W. TILLSON,
FREDERICK GREIFFENBERG.

COMMITTEES FOR 1903.

The President is *ex officio* a member of all committees.

STANDING COMMITTEES.

FINANCE

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Associates.—HENRY A. LA CHICOTTE, of the DEPARTMENT OF BRIDGES, and GEORGE S. RICE, of the RAPID TRANSIT RAILROAD COMMISSIONERS.

ON PRIZES

THEODOR S. OXHOLM, Chairman; CHARLES H. BULL, GEO. HALLETT CLARK.

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ON BADGE AND SEAL

HENRY R. ASSERSON, Chairman; BENJAMIN L. BLAUVELT, MARTIN GAY, EDWARD H. HOLDEN, CLARENCE D. POLLOCK.

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ARTHUR S. TUTTLE.

DIRECTORS

Term expires January, 1905.

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MAX RAYMOND,
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BERNARD M. WAGNER,
THEODOR S. OXHOLM.

Term expires January, 1906.

C. B. J. SNYDER,
JOHN C. WAIT,
EDWARD A. MILLER,
GEORGE W. TILLSON,
FREDERICK GREIFFENBERG.

Term expires January, 1907.

CHANDLER WITHINGTON,
HAROLD TAIT,
WILLIAM S. DALRYMPLE,
ROBERT RIDGWAY,
ROBERT R. CROWELL.

COMMITTEES FOR 1904.

The President is *ex officio* a member of all committees.

STANDING COMMITTEES.

FINANCE

SAMUEL C. THOMPSON, Chairman, *ex officio;* EDWARD A. BYRNE, WILLIAM W. BRUSH, WILLIAM S. DALRYMPLE, GEORGE A. TABER.

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ON INSPECTIONS

CHANDLER WITHINGTON, Manhattan, Chairman; CLARENCE D. POLLOCK, Brooklyn; DANIEL ULRICH, The Bronx; HERMAN K. ENDEMANN, Queens; JOHN T. FETHERSTON, Richmond.

PAST OFFICERS.

Officers of the Society since its organization.

PRESIDENT

NELSON P. LEWIS	1903-4

FIRST VICE-PRESIDENTS

OTHNIEL F. NICHOLS	1903
SAMUEL C. THOMPSON	1904

SECOND VICE-PRESIDENTS

SAMUEL C. THOMPSON	1903
HENRY A. LA CHICOTTE	1904

SECRETARY

WISNER MARTIN	1903-4

TREASURER

ARTHUR S. TUTTLE	1903-4

DIRECTORS

RUDOLPH HERING	1903
ROBERT RIDGWAY	1903-4-5-6
WILLIAM S. DALRYMPLE	1903-4-5-6
ROBERT R. CROWELL	1903-4-5-6
FREDERICK SKENE	1903
GEORGE S. RICE	1903-4
MAX RAYMOND	1903-4
HENRY R. ASSERSON	1903-4
BERNARD M. WAGNER	1903-4
THEODOR S. OXHOLM	1903-4
C. B. J. SNYDER	1903-4-5
JOHN C. WAIT	1903-4-5
EDWARD A. MILLER	1903-4-5
GEORGE W. TILLSON	1903-4-5
FREDERICK GREIFFENBERG	1903-4-5
CHANDLER WITHINGTON	1904-5-6
HAROLD TAIT	1904-5-6

LIST OF MEMBERS.

Note.—In addition to the provision of the Constitution, Article VII. Section 2. the Board of Directors has approved the following classification of members:

A member who is not attached to a department, commission, board or borough president's bureau should be assigned to the one of these with which his principal work is most nearly connected.

The borough should be indicated in which is the office of the member's own chief engineer or deputy commissioner or other officer whose authority over him corresponds to that of either of these.

Members are requested to notify the Secretary at once of any errors in this list and to inform him promptly of any change of address for mail matter.

Adriance, Thomas Floy. Engr., Highway Dept., Harrisburg, Pa.	30 Apr., 1903
Agramonte, Emilio, Jr. Asst. Engr., Dept. Water Supply, Gas and Elec., Manhattan, Park Row Bldg., Room 1520, New York	30 Apr., 1903
Allen, Austin Ewen. Asst. Engr. in Chg. of Lighting, Dept. Water Supply, Gas and Elec., Brooklyn, 170 Hawthorne St., Brooklyn	30 Apr., 1903
Andrus, Nathaniel Hammond. Leveler, Dept. Parks, Manhattan, 2013 Fifth Ave., New York	30 Apr., 1903
Ankener, Ernest. Asst. Engr., Topographical Bureau, Queens, 140 Twelfth Ave., Long Island City	30 Apr., 1903
Ankener, Richard. Transitman, Dept. Water Supply, Gas and Elec., Brooklyn, 140 Twelfth Ave.; Long Island City	30 Apr., 1903
Asserson, Henry Raymond. Chf. Engr., Bureau Sewers, Brooklyn, Floral Park, N. Y	30 Apr., 1903
Austen, Elmore Farrington. Asst. Engr., Bureau Sewers, The Bronx, Kingsbridge, N. Y	30 Apr., 1903
Baldwin, Richard, Jr. Asst. Engr., Aqueduct Com., Manhattan, Kingsbridge, N. Y	30 Apr., 1903
Balet, Joseph Wilhelmus. Asst. Engr., Dept. Bridges, Manhattan, 1958 Madison Ave., New York	30 Apr., 1903
Bascome, Western Radford. Asst. Engr., Dept. Bridges, Manhattan, 11 West 25th St., New York	30 Apr., 1903

Bassett, Elliot Thompson. Arch. Draftsman, Dept. Education, Manhattan, 19 North Broadway, Yonkers, N. Y. 30 Apr.,1903

Bayles, James Copper. Cons. Engr. to Borough President, Manhattan, 41 Park Row, New York.................. 30 Apr.,1903

Benedict, Clairville Ezra. Transitman, Aqueduct Com., Manhattan, Katonah, N. Y.... .... 30 Apr.,1903

Bensel, John Anderson. Engr.-in-Chief, Dept. Docks and Ferries, Manhattan, Pier A, North River, New York... 30 Apr.,1903

Bernhardt, Martin, Jr. Transitman, Offices Public Works, Richmond, 2594 Third Ave., New York.... .... 30 Apr.,1903

Betts, Fred Keeler. Asst. Engr., Dept. Water Supply, Gas and Elec., Manhattan, Katonah, N. Y................ 30 Apr.,1903

Bischof, George John. Asst. Engr. in Chg., Topographical Bureau, Brooklyn, 4 Court Square, Brooklyn......... 30 Apr.,1903

Blake, Richard Lowery. Transitman, Dept. Water Supply, Gas and Elec., Manhattan, High Bridge, N. Y........ 30 Apr.,1903

Blauvelt, Benjamin Lewis. Leveler, Aqueduct Com., Manhattan, 632 West 158th St., New York................ 30 Apr.,1903

Blum, Maximilian Lindheim. Topo. Draftsman, Bureau Highways, Manhattan, 175 East 80th St., New York... 30 Apr.,1903

Bonnett, Charles Pierre. Leveler, Topographical Bureau, The Bronx, Perry Avenue, Williamsbridge, N. Y 30 Apr.,1903

Brick, Samuel R., Jr. Deputy Supt. School Buildings, Dept. Education, Richmond, New Brighton, N. Y........... 30 Apr.,1903

Briggs, Josiah Ackerman. Chf. Engr., Offices Borough President, The Bronx, Municipal Bldg., Third Ave. and 177th St., New York................................. 30 Apr.,1903

Brink, Lawrence Calvin. Asst. Engr., Rapid Transit R. R. Com., Manhattan, 147 Columbus Ave., New York..... 30 Apr.,1903

Broadhurst, William Homer. Chemist, Bureau Highways, Brooklyn, Municipal Bldg., Room 51, Brooklyn....... 30 Apr.,1903

Browne, Martin Joseph. Prin. Asst. Engr., Bureau Sewers, Manhattan, Park Row Bldg., Room 1309, New York... 30 Apr.,1903

Brush, James Lyles, Jr. Arch. Draftsman, Dept. Education, Brooklyn, 547 Pacific St., Brooklyn.................. 30 Apr.,1903

Brush, William Whitelock. Asst. Engr., Dept. Water Supply, Gas and Elec., Brooklyn, Municipal Bldg., Room 41, Brooklyn.. 30 Apr.,1903

Bull, Charles Hudson. Asst. Engr., Dept. Water Supply, Gas and Elec., Manhattan, 702 Madison Ave., New York 30 Apr.,1903

Bunting, William Charles. Transitman, Dept. Parks, Manhattan, 333 East 118th St., New York................ 30 Apr.,1903

Burgess, Alfred Samuel. Topo. Draftsman, Aqueduct Com., Manhattan, 2092 Bathgate Ave., New York..... 30 Apr.,1903

Burr, William Hubert. Prof. of Civ. Eng., Columbia Univ. and Cons. Engr., 151 West 74th St., New York	23 Dec.,1903
Byrne, Edward A. Asst. Engr., Dept. Bridges, Manhattan, 1054 Bergen St., Brooklyn	30 Apr.,1903
Carpenter, Frederick Wisner. Senior Asst. Engr., Rapid Transit R. R. Com., Manhattan, 231 West 125th St., New York	30 Apr.,1903
Carr, Albert. Div. Engr., Rapid Transit R. R. Com., Manhattan, 122 Liberty St., New York	30 Apr.,1903
Clark, George Hallett. Senior Asst. Engr., Rapid Transit R. R. Com., Manhattan, 406 West End Ave., New York	30 Apr.,1903
Clarke, Ernest Wilder. Asst. Engr., Rapid Transit R. R. Com., Manhattan, 40 North Parsons Ave., Flushing, N. Y.	30 Apr.,1903
Clarke, John P. Draftsman, Bureau Sewers, Brooklyn, 692 Union Ave., New York	30 Apr.,1903
Clarke, St. John. General Inspr. of Designs, Rapid Transit R. R. Com., Manhattan, Bogota, N. J	30 Apr.,1903
Clarke, Thomas Joseph. Leveler, Bureau Highways, Queens, 32 North Washington Pl., Astoria, N. Y	30 Apr.,1903
Cleverdon, Walter Sherman Lyle. Topo. Draftsman, Dept. Water Supply, Gas and Elec., Brooklyn, 551 East 179th St., New York	30 Apr.,1903
Coffman, Herbert Burns. Inspr. of Iron and Steel, Dept. Education, Manhattan, 801 East 167th St., New York	30 Apr.,1903
Cohen, Walter Wolfe. Transitman, Bureau Sewers, The Bronx, 1961 Anthony Ave., New York	30 Apr.,1903
Connell, William Henry. Rodman, Bureau Highways, Brooklyn, Bedford Park, New York	30 Apr.,1903
Cornell, George F. Leveler, Bureau Highways, Richmond, Rosebank, N. Y	30 Apr.,1903
Cox, Leroy Francis. Topo. Draftsman, Dept. Water Supply, Gas and Elec., Manhattan, 38 Washington Square West, New York	30 Apr.,1903
Cranmer, Ralph. Asst. Engr., Rapid Transit R. R. Com., Manhattan, New Brighton, N. Y	30 Apr.,1903
Craven, Alfred. Div. Engr., Rapid Transit R. R. Com., Manhattan, 1947 Broadway, New York	30 Apr.,1903
Craven, Macdonough. Engr. in Chg. of Sanitation Work at Barren Island, Dept. Street Cleaning, Manhattan, 263 82d St., Brooklyn	30 Apr.,1903
Creeden, John Furlong. Asst. Engr., Offices Public Works, Richmond, 455 West 23d St., New York	30 Apr.,1903
Crowell, Robert Reynolds. Asst. Engr. in Chg., Topographical Bureau, Queens, 73 Herriman Ave., Jamaica, N. Y	30 Apr.,1903

Crowley, William Joseph. Transitman, Dept. Docks and Ferries, Manhattan, 666 East 142d St., New York	23 Dec.,1903
Culgin, Guy Whitmore. Culgin & Pace, Engrs. and Gen. Contrs., 133 West 129th St , New York	30 Apr.,1903
Culyer, Thurston Carlyle. Asst. Engr., Dept. Water Supply, Gas and Elec., Manhattan, Purdy Station, N. Y.	30 Apr.,1903
Cummings, Noah. Asst. Engr , Dept. Bridges, Manhattan, 213 West 136th St., New York	30 Apr.,1903
Cunningham, Joseph Bernard. Leveler, Bureau Highways, Manhattan, 114 Waverly Place, New York	30 Apr.,1903
Curtin, Daniel Andrew. Asst. Engr., Bureau Highways, The Bronx, 2699 Creston Ave., New York	30 Apr.,1903
Dahm, Sverre. Asst. Engr., Rapid Transit R. R. Com., Manhattan, R. T. Com., Chf. Engr.'s office, 320 Broadway, New York	30 Apr.,1903
Dalrymple, William Spear. Asst. Engr., Topographical Bureau, The Bronx, 219 East 60th St., New York	30 Apr.,1903
Daube, Henry. Draftsman, Taxes and Assessments, Manhattan, Hackett Bldg., Long Island City	30 Apr.,1903
Deignan, John Eugene. Transitman, Dept. Water Supply, Gas and Elec., Manhattan, 5 West 8th St., New York	30 Apr.,1903
de Lancey, Edward Etienne. Asst. Engr., Aqueduct Com., Manhattan, 7 Lincoln Place, Ossining, N. Y.	30 Apr.,1903
de Luze, Louis Philippe. Asst. Engr,, Rapid Transit R. R. Com., Manhattan, 380 Pelham Road, New Rochelle, N. Y.	30 Apr.,1903
de Varona, Ignatio Maréa. Chf. Engr., Dept. Water Supply, Gas and Elec., Brooklyn, 42 West 120th St., New York	30 Apr.,1903
Devoe, Harry Malcolm. Deputy Supt. School Buildings, Dept. Education, Manhattan, 500 Park Ave., New York.	30 Apr.,1903
Dey, Wesley Elwood. Asst. Engr., Bureau Sewers, The Bronx, Monroe and Burnside Aves., New York	30 Apr.,1903
Doyle, William Thomas. Topo. Draftsman, Bureau Sewers, Brooklyn, 183 Gates Ave., Brooklyn	30 Apr.,1903
Drake, Frederick Augustus. Leveler, Bureau Highways, Brooklyn, 446 80th St., Brooklyn	30 Apr.,1903
Duncan, William Joseph. Asst. Engr., Rapid Transit R. R. Com., Manhattan, 320 Broadway, New York	30 Apr.,1903
Duncklee, John Butler. Supt., Tenement House Dept., Manhattan, 2806 Third Ave., New York	30 Apr.,1903
Dunsing, William Joseph. Transitman, Bureau Highways, The Bronx, 1484 Minford Place, New York	30 Apr.,1903
Durham, Henry Welles. Asst. Engr., Rapid Transit R. R. Com., Manhattan, 10 Bridge St., New York	30 Apr.,1903

Durham. Leicester. Asst. Engr., Rapid Transit R. R. Com., Manhattan, 404 West 145th St., New York	30 Apr.,1903
Durney, John Francis. Rodman, Dept. Water Supply, Gas and Elec., Brooklyn, 1074 Third Ave., New York	30 Apr.,1903
Dusenberry, Howard Woodrow. Leveler, Dept. Parks, Brooklyn	30 Apr.,1903
Ebert. Edward Tilden. Leveler, Bureau Highways, The Bronx, 862 Union Ave., New York	30 Apr.,1903
Eliot, Walter Graeme. Topo. Draftsman, Topographical Bureau, Queens, 1 West 54th St., New York	30 Apr.,1903
Endemann. Herman Karl. Asst. Engr., Topographical Bureau, Queens, 46 Herriman Ave., Jamaica, N. Y	30 Apr.,1903
Erlandsen, Olcar. Asst. Engr., Dept. Bridges, Manhattan, 32 Sutton Place, New York	30 Apr.,1903
Farley. Philip Patrick. Asst. Engr., Rapid Transit R. R. Com., Manhattan, 329 Macon St., Brooklyn	30 Apr.,1903
Farmer. Alexander Simpson. Mech. Draftsman, Dept. Water Supply, Gas and Elec., Manhattan, 140 Rodney St., Brooklyn	30 Apr.,1903
Farrell. Dennis. Transitman, Bureau Highways, Manhattan, 15 Sylvan Terrace, New York	30 Apr.,1903
Ferguson, George Robert. Asst. Engr., Dept. Bridges, Manhattan, Park Row Bldg., New York	30 Apr.,1903
Ferris. James Reynolds. Rodman, Rapid Transit R. R. Com., Manhattan, 217 West 12th St., New York	30 Apr.,1903
Fetherston, John Turney. Asst. Engr., Bureau Sewers, Richmond, 5 York Ave., New Brighton, N. Y.	30 Apr.,1903
Fintel, Ernest August. Transitman, Dept. Bridges, Manhattan, 86 Himrod St., Brooklyn	30 Apr.,1903
Fowler, Frank George. Topo. Draftsman, Bureau Highways, The Bronx, Mount Kisco, N. Y	30 Apr.,1903
Foy, William Gabriel. Leveler, Bureau Highways, Brooklyn, 1987 Crotona Ave., New York	30 Apr.,1903
Freeman, Llewellyn Warren. Asst. Engr., Bureau Sewers, Richmond, Post Office Box 43, Mariners Harbor, N. Y.	30 Apr.,1903
Frost, George Sherman. Asst. Engr., Rapid Transit R. R. Com., Manhattan, 1947 Broadway, New York	30 Apr.,1903
Gaffney, Cornelius. Asst. Engr., Rapid Transit R. R. Com., Manhattan, 322 East 58th St., New York	30 Apr.,1903
Gartensteig, Charles. Asst. Engr., Offices Borough President, The Bronx, 12 East 87th St., New York	30 Apr.,1903
Gay, Martin. Asst. Engr., Dept. Bridges, Manhattan, Park Row Bldg., New York	30 Apr.,1903

Gecks, Henry. Leveler, Bureau Sewers, The Bronx, 605 Eagle Ave., New York	30 Apr., 1903
Geoghan, Joseph Richard. Asst. Engr., Rapid Transit R. R. Com., Manhattan, 151 West 102d St., New York	30 Apr., 1903
Goge, Alexander Morrison. Draftsman, Dept. Docks and Ferries, Manhattan, 926 Madison Ave., New York	30 Apr., 1903
Goodridge, John Wesley. Asst. Engr., Rapid Transit R. R. Com., Manhattan, 292 Marlborough Road, Brooklyn	30 Apr., 1903
Goodsell, Daniel Bertholf. Transitman, Bureau Highways, Manhattan, Park Row Bldg., Room 1629, New York	30 Apr., 1903
Green, Charles Newton. Asst. Engr., Rapid Transit R. R. Com., Manhattan, 1947 Broadway, New York	30 Apr., 1903
Gregory, Edwin Clinton. Transitman, Dept. Parks, Manhattan, 282 Alexander Ave., New York	30 Apr., 1903
Greiffenberg, Frederick. Prin. Asst. Topo. Engr., Offices Borough President, The Bronx, 222 West 24th St., New York	30 Apr., 1903
Greiffenberg, Frederick Louis. Asst. Engr., Topographical Bureau, Queens, 461 State St., Flushing, N. Y.	30 Apr., 1903
Griffiths, John David. Asst. Engr., Dept. Water Supply, Gas and Elec., Brooklyn, Municipal Bldg., Room 41, Brooklyn	30 Apr., 1903
Grünenthal, Anthony Francis. Draftsman, Offices Borough President, Richmond, First St., New Brighton, N. Y.	30 Apr., 1903
Gunter, Evan Lord. Arch. Draftsman, Dept. Education, Manhattan, 169 West 80th St., New York	30 Apr., 1903
Haas, Philip Lippmann. Transitman, Topographical Bureau, The Bronx, 307 St. Ann's Ave., New York	30 Apr., 1903
Hammond, George Tillinghast. Asst. Engr., Bureau Sewers, Brooklyn, 156 Berkeley Place, Brooklyn	30 Apr., 1903
Hammond, John Farnsworth. Asst. Engr., Bureau Sewers, Brooklyn, 335 Flatbush Ave., Brooklyn	30 Apr., 1903
Hankinson, Albert W. Asst. Engr., Dept. Finance, Manhattan, 62 West 85th St., New York	30 Apr., 1903
Hartmann, Edward Lewis. Asst. Engr., Bureau Sewers, The Bronx, 1006 East 165th St., New York	30 Apr., 1903
Haswell, Charles Haynes. Asst. Engr., Board Estimate and Apportionment, Manhattan, 324 West 78th St., New York	30 Apr., 1903
Hayman, Jacob. Topo. Draftsman, Dept. Water Supply, Gas and Elec., Brooklyn, 45 St. Marks Ave., Brooklyn.	30 Apr., 1903
Head, Henry Culver. Transitman, Topographical Bureau, Brooklyn, 4 Court Square, Brooklyn	30 Apr., 1903

Hefele, Joseph Francis. Transitman, Topographical Bureau, The Bronx, 4 Gouverneur Place, New York	30 Apr., 1903
Hennessy, William Paul. Asst. Engr., Dept. Parks, The Bronx, 337 East 123d St., New York	30 Apr., 1903
Herbert, Arthur. Transitman, Dept. Parks, Manhattan, 249 Cedar Road, New Rochelle, N. Y.	30 Apr., 1903
Herckenrath, Walter Augustus. Asst. Engr., Topographical Bureau, The Bronx, 463 East 176th St., New York.	30 Apr., 1903
Hering, Rudolph. Hydr. and Sany. Engr., 170 Broadway, New York	30 Apr., 1903
Herrmann, Edward Peter. Rodman, Dept. Bridges, Manhattan, 58 East 124th St., New York	30 Apr., 1903
Hildreth, Percy Stearns. Examiner, Civil Service Com., Manhattan, 50 Broadway, New York	30 Apr., 1903
Hill, Nicholas Snowden, Jr. Chf. Engr., Dept. Water Supply, Gas and Elec., Manhattan, 243 West 98th St., New York	30 Apr., 1903
Hill, William Ryan. 242 Sixth Ave., Brooklyn	30 Apr., 1903
Hillyer, William Ross. Asst. Comr. of Public Works, Offices Borough President, Richmond, Richmond Bldg., New Brighton, N. Y.	30 Apr., 1903
Hipkins, Bayly. Asst. Engr., Rapid Transit R. R. Com., Manhattan, 147 Columbus Ave., New York	30 Apr., 1903
Hochlerner, Tobias. Leveler, Bureau Sewers, Brooklyn, 204 Henry St., New York	30 Apr., 1903
Holden, Edward Henry. Asst. Engr., Topographical Bureau, The Bronx, Municipal Bldg., Third Ave. and 177th St., New York	30 Apr., 1903
Horgan, John George. Rodman, Bureau Highways, Manhattan, 2051 Fifth Ave., New York	30 Apr., 1903
Howe, Horace Joseph. Asst. Engr., Rapid Transit R. R. Com., Manhattan, 231 West 125th St., New York	30 Apr., 1903
Hufeland, Otto. Asst. Engr., Bureau Sewers, Manhattan, Park Row Bldg., Room 1339, New York	30 Apr., 1903
Hunter, Jeremiah, Leveler, Bureau Highways, Manhattan, Park Row Bldg., New York	23 Dec., 1903
Hurlbut, Samuel Ray. Chf. Draftsman, Offices Borough President, Richmond, 34 Central Ave., Tompkinsville, N. Y.	30 Apr.. 1903

Jackson, Daniel Dana. Chf. Chemist, Dept. Water Supply, Gas and Elec., Brooklyn, 941 President St., Brooklyn	30 Apr., 1903
Jennings, Edwin Bloom. Asst. Engr., Dept. Bridges, Manhattan, 11 West 83d St., New York	30 Apr., 1903

Johnes, William Foulke. Asst. Engr., Bureau Sewers, The Bronx, 1215 East 167th St., New York	30 Apr.,1903
Johnson, Edward Burnet. Rodman, Rapid Transit R. R. Com., Manhattan, 59 Bainbridge St., Brooklyn	24 Feb.,1904
Johnson, James H. Chf. Engr., Bureau Sewers, Queens, 41 Jackson Ave., Long Island City	30 Apr.,1903
Johnson, Robert Thornton. Asst. Engr., Topographical Bureau, Queens, 2441 Seventh Ave., New York	30 Apr.,1903
Johnson, William Gervaise. Asst. Engr., Dept. Docks and Ferries, Manhattan, 599 McDonough St., Brooklyn	30 Apr.,1903
Kearney, James. Asst. Engr., Rapid Transit R. R. Com., Manhattan, St. Ann's Ave. and 132d St., New York	30 Apr.,1903
Keogh, William J. Rodman, Rapid Transit R. R. Com., Manhattan, 2636 Third Ave., New York	30 Apr.,1903
Kipp, Burdett. Asst. Engr., Rapid Transit R. R. Com., Manhattan, 20 West 121st St., New York	30 Apr.,1903
Kirby, Isaac H. Transitman, Bureau Sewers, Brooklyn, Municipal Bldg., Brooklyn	30 Apr.,1903
Kleeberg, Felix. Chemist, Bureau Highways, Manhattan, 211 East 85th St., New York	23 Dec.,1903
Knap, Edgar Day. Asst. Engr., Dept. Bridges, Manhattan, 84 Broadway, Brooklyn	30 Apr.,1903
Knight, George Henry. Leveler, Bureau Sewers, Brooklyn, 300 Manhattan Ave., New York	30 Apr.,1903
Knighton, John Albert. Asst. Engr., Dept. Bridges, Manhattan, Manhattan Bridge Office, 77 Pike Slip, New York.	30 Apr.,1903
Koch, Frank Alexander. Mech. Engr., Dept. Parks, Manhattan, The Arsenal, Central Park, New York	30 Apr.,1903
Krug, George. Mech. Draftsman, Dept. Education, The Bronx, 131 Livingston St., Brooklyn	30 Apr.,1903
Laase, William Frederick. Transitman, Dept. Water Supply, Gas and Elec., Brooklyn, 75 Sixth Ave., Brooklyn	30 Apr.,1903
La Chicotte, Henry Arthur. Prin. Asst. Engr., Dept. Bridges, Manhattan, Park Row Bldg., New York	30 Apr.,1903
La Forge, Adrian. Transitman, Topographical Bureau, Queens, 22 West 128th St., New York	30 Apr.,1903
Lance, Emil Joseph. Engr., Dept. Education, Manhattan, 600 Park Ave., New York	30 Apr.,1903
Lesley, George Herbert. Topo. Draftsman, Rapid Transit R. R. Com., Manhattan, Spuyten Duyvil, N. Y.	30 Apr.,1903
Lewis, Myron Henry. Transitman, Aqueduct Com., Manhattan, 1076 Lexington Ave., New York	30 Apr.,1903

Lewis, Nelson Peter. Chf. Engr., Board Estimate and Apportionment, Manhattan, City Hall, New York........ 30 Apr.,1903

Lintz, William Deegan. Transitman, Dept. Water Supply, Gas and Elec., Manhattan, 838 East 167th St., New York... 30 Apr.,1903

Livingston, D. McRa. Leveler, Dept. Parks, Manhattan, 132 West 12th St., New York........................ 30 Apr.,1903

Lobo, Carlos. Transitman, Dept. Water Supply, Gas and Elec., Brooklyn, Municipal Bldg., Room 41, Brooklyn.. 30 Apr.,1903

Lodholz, Abraham. Asst. Engr., Rapid Transit R. R. Com., Manhattan, 311 East 90th St., New York.... .... 30 Apr.,1903

Loomis, Horace Chf. Engr., Bureau Sewers, Manhattan, Park Row Bldg., New York 30 Apr.,1903

Lurye, Henry Isadore. Leveler, Bureau Sewers, Brooklyn, 57 East 117th St., New York..................... ... 30 Apr.,1903

Lutz, Ulysses Simpson. Topo. Draftsman, Topographical Bureau, Richmond, Post Office Box 70, New Brighton, N. Y.. 30 Apr.,1903

Lynch, Henry J. Rodman, Bureau Sewers, Brooklyn, 177 East 64th St., New York.......................... 30 Apr.,1903

MacDonald, William. Transitman, Topographical Bureau, Richmond, 74 Broadway, Port Richmond, N. Y....... 30 Apr.,1903

Madden, John Henry. Asst. Engr., Rapid Transit R. R. Com., Manhattan, 308 West 30th St., New York....... 30 Apr.,1903

Magrath, John Robert. Asst. Engr., Rapid Transit R. R. Com., Manhattan, 2024 Lexington Ave., New York.... 30 Apr.,1903

Manning, Charles Curtiss. Arch. Draftsman, Aqueduct Com., Manhattan, 312 47th St., Brooklyn............. 30 Apr.,1903

Marrin, Wilfrid Edward. Leveler, Bureau Highways, The Bronx, Kingsbridge, N. Y 30 Apr.,1903

Martin, Kingsley Leverich. Asst. Engr., Dept. Bridges, Manhattan, 84 Broadway, Brooklyn................. 30 Apr.,1903

Martin, Wisner. Prin. Asst. Engr., Bureau Highways, Manhattan, Park Row Bldg., New York.................. 30 Apr.,1903

Maulbeck, Sebastian. Topo. Draftsman, Dept. Parks, Manhattan, 351 Saratoga Ave., Brooklyn................. 30 Apr.,1903

Maurer, Edmund John. Draftsman, Dept. Water Supply, Gas and Elec., Manhattan, High Bridge, N. Y........... 30 Apr.,1903

Mayell, Albert Jefferson. Asst. Engr., Rapid Transit R. R. Com., Manhattan, 550 East 164th St., New York.... 30 Apr.,1903

Mazeau, Camille. Asst. Engr., New York, New Haven & Hartford R. R. Co., Washington Ave., West Chester, N. Y.... .... 30 Apr.,1903

McCready, Ernest Brodhead. Cement Inspr., Rapit Transit R. R. Com., Manhattan, 414 Turner St., Allentown, Pa. 30 Apr., 1903

McDonald, William Stewart. Asst. Engr., Dept. Parks, Manhattan, 25 Radford St., Yonkers, N. Y. .... 30 Apr., 1903

McGraw, John Prescott. Draftsman, Bureau Sewers, Queens, 359 Webster Ave., Long Island City .... 30 Apr., 1903

McGuire, James J., Jr. Rodman, Rapid Transit R. R. Com., Manhattan, 10 Bridge St., New York .... 30 Apr., 1903

McKenna, James. Topo. Draftsman, Law Dept., Manhattan, 90 West Broadway, New York .... 30 Apr., 1903

McKim, Robert Albert. Asst. Engr., Aqueduct Com., Manhattan, 280 Broadway, New York .... 30 Apr., 1903

McLean, Archibald. Asst. Engr., Dept. Bridges, Manhattan, 179 Washington St., Brooklyn .... 30 Apr., 1903

Meagher, Stephen Eugene. Rodman, Rapid Transit R. R. Com., Manhattan, 640 West 138th St., New York .... 30 Apr., 1903

Melius, Theodore. Transitman, Dept. Water Supply, Gas and Elec., Manhattan, Park Row Bldg., Room 1520, New York .... 30 Apr., 1903

Miller, Edward Adelberg. Chf. Engr., Dept. Parks, Manhattan, 1227 Tinton Ave., New York .... 30 Apr., 1903

Mills, William Warford. Asst. Engr., Rapid Transit R. R. Com., Manhattan, Div. Engr.'s Office, 231 West 125th St., New York .... 30 Apr., 1903

Mimnaugh, Arthur Jerome. Leveler, Dept. Docks and Ferries, Manhattan, 311 East 20th St., New York ...... 30 Apr., 1903

Moisseiff, Leon Solomon. Asst. Engr., Dept. Bridges, Manhattan, Park Row Bldg., New York .... 30 Apr., 1903

Moore, William Sims. Draftsman, Bureau Sewers, Brooklyn, 73 North Ave., New Rochelle, N. Y. .... 30 Apr., 1903

Morton, Edmund Quincy. Topo. Draftsman, Topographical Bureau, Manhattan, Park Row Bldg., Room 1839, New York .... 30 Apr., 1903

Mueller, Conrad Julius. Topo. Draftsman, Topographical Bureau, Queens, 2152 Lafontaine Ave., New York ..... 30 Apr., 1903

Muenz, Sigmund. Topo. Draftsman, Offices Public Works, Richmond, 130 Dryden Road, Ithaca, N. Y. .... 30 Apr., 1903

Mulcahy, Cornelius. Topo. Draftsman, Rapid Transit R. R. Com., Manhattan, 2117 Arthur Ave., New York .... 30 Apr., 1903

Munckwitz, Julius Frederick. Architect, Dept. Parks, Manhattan, 125 West 129th St., New York .... 30 Apr., 1903

Murphy, Peter Joseph. Transitman, Dept. Bridges, Manhattan, 925 Jefferson Place, New York .... 30 Apr., 1903

Nagy, Alexander. Topo. Draftsman, Topographical Bureau, Queens, 27 Fort Greene Place, Brooklyn .... 30 Apr., 1903

Nagy, Eugene. Topo. Draftsman, Bureau Highways, Manhattan, 52 West 132d St., New York	30 Apr., 1903
Nichols, Othniel Foster. Ch. Engr., Dept. Bridges, Manhattan, 42 Gates Ave., Brooklyn	30 Apr., 1903
Noble, Frederick Charles. Asst. Engr., Rapid Transit R. R. Com., Manhattan, 439 West 123d St., New York	30 Apr., 1903
O'Connor, John. Leveler, Aqueduct Com., Manhattan, Brewster, N. Y	30 Apr., 1903
Olney, George Romaine. Chf. Engr., Bureau Highways, Manhattan, 210 West 107th St., N. Y	30 Apr., 1903
Osterhout, William Bigler. Asst. Engr., Dept. Water Supply, Gas and Elec., Brooklyn, Freeport, N. Y	30 Apr., 1903
Owen, John. Computer, Topographical Bureau, The Bronx, 2442 Lorillard Place, New York	30 Apr., 1903
Oxholm, Theodor Smidt. Prin. Asst. Engr., Offices Borough President, Richmond, St. Austin's Place, West New Brighton, N. Y	30 Apr., 1903
Pentz, George Shannon. Draftsman, Fire Dept., Manhattan, 159 East 67th St., New York	30 Apr., 1903
Perry, Frank Jason. Asst. Engr., Rapid Transit R. R. Com., Manhattan, 46 Jefferson Ave., Richmond Hill, N. Y	30 Apr., 1903
Plassman, Ernest Joseph. Topo. Draftsman, Topographical Bureau, The Bronx, 166 Pleasant Ave., Williamsbridge, N. Y	30 Apr., 1903
Pollock, Clarence DuBois. Asst. Engr., Bureau Highways, Brooklyn, 531 East 23d St., Brooklyn	30 Apr., 1903
Powell, Charles Underhill. Asst. Engr., Topographical Bureau, Queens, Broadway and Sanford Ave., Flushing, N. Y	30 Apr., 1903
Powers, Cornelius Van Vorst. Div. Engr., Rapid Transit R. R. Com., Manhattan, 134 West 75th St., New York	30 Apr., 1903
Price, Rodman McCamly. Chf. Engr., Dept. Parks, Brooklyn, 420 Seventh St., Brooklyn	30 Apr., 1903
Probasco, Samuel R. Asst. Engr., Bridges, Manhattan, 107 Montague St., Brooklyn	30 Apr., 1903
Provost, Andrew J., Jr. Asst. Engr., Dept. Finance, Manhattan, 280 Broadway, New York	30 Apr., 1903
Pyne, William Lyons. Leveler, Bureau Sewers, Queens, 15 Dugan Ave., Jamaica, N. Y	30 Apr., 1903
Raisman, Aaron Israel. Asst. Engr., Rapid Transit R. R. Com., Manhattan, 504 West 151st St., New York	30 Sep., 1903
Raymond, Max. Asst. Engr., Dept. Docks and Ferries, Manhattan, Pier A, North River, New York	30 Apr., 1903

Raynor, Clarence Elmer. Topo. Draftsman, Law Dept., Manhattan, 459 59th St., Brooklyn	30 Apr.,1903
Reeve, John Seville. With Hastings Pavement Co., 527 West 173d St., New York	30 Apr.,1903
Reichelt, Victor Hugo. Transitman, Bureau Sewers, Richmond, 1 Central Ave., Tompkinsville, N. Y	30 Apr.,1903
Reid, Homer Austin. Examining Engr., Com. Accounts, Manhattan, 280 Broadway, Room 105, New York	30 Apr.,1903
Reton, Clarence Geer. Leveler, Dept. Parks, Manhattan, 261 West 128th St., New York	30 Apr.,1903
Rice, George Staples. Deputy Chf. Engr., Rapid Transit R. R. Com., Manhattan, Audubon Park, West 157th St., New York	30 Apr.,1903
Richards, William Farlin. Prin. Asst. Engr., Dept. Parks, Manhattan, 1244 Madison Ave., New York	30 Apr.,1903
Riches, James Henry. Asst. Engr., Bureau Highways, Richmond, 19 Dongan St., West New Brighton, N. Y	30 Apr.,1903
Ridgway, Robert. Div. Engr., Rapid Transit R. R. Com., Manhattan, 504 West 143d St., New York	30 Apr.,1903
Riedel, John Charles. Transitman, Bureau Sewers, Brooklyn, 686 Halsey St., Brooklyn	30 Apr.,1903
Riordan, Edward. Transitman, Topographical Bureau, Brooklyn, 42 West 117th St., New York	30 Apr.,1903
Risse, Charles Edmund. Leveler, Topograpical Bureau, The Bronx, 571 East 145th St., New York	30 Apr.,1903
Roach, William Eugene. Asst. Engr., Dept. Finance, Manhattan, 234 Greene Ave., Brooklyn	30 Apr.,1903
Roberts, Winfred Henry. Asst. Engr., Dept. Finance, Manhattan, 670 President St., Brooklyn	30 Apr.,1903
Robinson, Holton Duncan. Asst. Engr., in Chg. Williamsburg Bridge, Dept. Bridges, Manhattan, 357 West 121st St., New York	30 Apr.,1903
Rodman, George Edward. Leveler, Dept. Water Supply, Gas and Elec., Manhattan, Park Row Bldg., Room 1520, New York	30 Apr.,1903
Roffe, William Alfred. Topo. Draftsman, Rapid Transit R. R. Com., Manhattan, 777 East 178th St., New York.	24 Feb.,1904
Rogers, Frederick B. Asst. Engr., Aqueduct Com., Manhattan, Ossining, N. Y	30 Apr.,1903
Rowan, William Ayr. Topo. Draftsman, Topographical Bureau, Queens, 687 East 160th St., New York	
Rubien, Frederick William. Draftsman, Dept. Taxes and Assessments, Manhattan, 408 East 15th St., New York.	30 Apr.,1903
Ruge, Herman Arnold. Topo. Draftsman, Dept. Water Supply, Gas and Elec., Manhattan, 8 East 85th St., New York	30 Apr.,1903

Ryan, William Sylvester. Rodman, Dept. Water Supply, Gas and Elec., Manhattan, 1477 Lexington Ave., New York.. 30 Apr., 1903

Schaeffer, Amos. Asst. Engr., Rapid Transit R. R. Com., Manhattan, 500 West 149th St., New York............ 30 Apr., 1903

Schenck, Martin. Chf. Engr., Dept. Parks, The Bronx, Claremont Park, New York........................ 30 Apr., 1903

Schermerhorn, John Peter. Asst. Engr., Aqueduct Com., Manhattan, 131 West 130th St., New York............ 30 Apr., 1903

Schmitt, Jacob. Transitman, Bureau of Highways, Brooklyn, 36 South Oxford St., Brooklyn.................. 30 Apr., 1903

Schreiner, Alberto. Topo. Draftsman, Bureau Sewers, Queens, Hackett Bldg., Room 6, Long Island City.... 30 Apr., 1903

Schwietzer, George John. Topo. Draftsman, Topographical Bureau, Brooklyn, 5 Glenada Place, Brooklyn........ 30 Apr., 1903

Serber, David Charles. With Henry Steers, Jr., 28 West 120th St., New York.................................. 30 Apr., 1903

Sever, George Francis. Cons. Elec. Engr., Dept. Water Supply, Gas and Elec., Manhattan, Columbia University, New York...................................... 30 Apr., 1903

Shertzer, Tyrrell Bradbury. Asst. Engr., Rapid Transit R. R. Com., Manhattan, 621 West 152d St., New York.... 30 Apr., 1903

Shipman, Jesse Oliver. Asst. Engr., Rapid Transit R. R. Com., Manhattan, 32 West 15th St., New York........ 30 Apr., 1903

Skene, Frederick. Asst. Engr., Bureau Highways, Queens, 411 Lockwood St., Astoria, N. Y....................... 30 Apr., 1903

Skilton, George Steele. Asst. Engr., Dept. Water Supply, Gas and Elec., Brooklyn, Rockville Center, N. Y...... 30 Apr., 1903

Smith, Leonard Charles Lindsay. Asst. Engr., Dept. Water Supply, Gas and Elec., Manhattan, 59 Woolsey St., Long Island City.................................. 30 Apr., 1903

Snyder, C. B. J. Supt. of School Buildings, Dept. Education, Manhattan, Park Ave. and 59th St., New York... .... 30 Apr., 1903

Sonn, Louis. Topo. Draftsman, Rapid Transit R. R. Com., Manhattan, 1 Gouverneur Place, New York........... 30 Apr., 1903

Stander, Isaac Joshua. Asst. Engr., Dept. Docks and Ferries, Manhattan, 11 West 112th St., New York........ 30 Apr., 1903

Steers, Charles Henry. Transitman, Dept. Water Supply, Gas and Elec., Manhattan, 2162 Washington Ave., New York.. 30 Apr., 1903

Stein, John B. Topo. Draftsman, Topographical Bureau, Brooklyn, 407 East 16th St., Brooklyn.............. 30 Apr., 1903

Strinacher, Gustavo José. Rodman, Bureau Highways, Manhattan, Park Row Bldg., Room 1616, New York... 30 Apr., 1903

Steinmetz, William Frederick. Topo. Draftsman, Rapid Transit R. R. Com., Manhattan, 606 East 84th St., New York.......................... 30 Apr.,1903

Stepath, Charles. Transitman, Bureau Highways, The Bronx, 154 West 122d St., New York.................. 30 Apr.,1903

Stout, Ellarson. Asst. Engr., Topographical Bureau, Richmond, New Brighton, N. Y. 30 Apr.,1903

Sullivan, Charles Purcell. Transitman, Dept. Water Supply, Gas and Elec., Brooklyn, 599A Macon St., Brooklyn.......................... 30 Apr.,1903

Sunkle, George Henry. Rodman, Rapid Transit R R. Com., Manhattan, 498 Manhattan Ave , New York..... 30 Apr.,1903

Taber, George Aymar. Asst. Engr., Dept. Water Supply, Gas and Elec., Manhattan, Park Row Bldg., Room 1521, New York.. 30 Apr.,1903

Tait, Harold. Asst. Engr., Bureau Sewers, Queens, Hackett Bldg., Long Island City....................... 30 Apr.,1903

Taylor, Alexander Robinson. Draftsman, Dept. Water Supply, Gas and Elec., Manhattan, 38 Livingston Ave., Yonkers, N. Y.. 30 Apr.,1903

Theban, John Gerard. Asst. Engr., Dept. Bridges, Manhattan, Pelham Bay Park, New York.................. 30 Apr.,1903

Thomes, Edwin Howard. Asst. Engr., Rapid Transit R. R. Com., Manhattan, 150 Willett St., Jamaica, N. Y..... 30 Apr.,1903

Thompson, Samuel Clarence. Prin. Asst. Engr., Highways, Offices Borough President, The Bronx, Municipal Bldg., Third Ave. and 177th St., New York............ 30 Apr.,1903

Thomson, Alexander, Jr. Asst. Engr., Rapid Transit R. R. Com., Manhattan, 351A Quincy St., Brooklyn........ 30 Apr.,1903

Tillson, George William. Chf. Engr., Bureau Highways, Brooklyn, Municipal Bldg., Room 12, Brooklyn....... 30 Apr.,1903

Tilly, John A. Asst. Engr., Dept. Bridges, Manhattan, 494 Quincy St., Brooklyn.................................. 30 Apr.,1903

Torrence, Kenneth. Chf. Engr., Ridgewood Pumping Station, Dept. Water Supply, Gas and Elec., Brooklyn, 225 Logan St., Brooklyn.................................. 30 Apr.,1903

Tribus, Louis Lincoln. Comr. of Public Works, Offices Borough President, Richmond, 84 Warren St., New York 30 Apr.,1903

Turner, Daniel Lawrence. Asst. Engr. in Chg. of Stations, Rapid Transit R. R Com., Manhattan, 220 West 107th St., New York.................................. 30 Apr.,1903

Tuttle, Arthur Smith. Asst. Engr., Board of Estimate and Apportionment, Manhattan, City Hall, New York..... 30 Apr.,1903

Tuttle, George William. Asst. Topo. Engr., Topographical Bureau, Richmond, 4 Tompkins Ave., New Brighton, N. Y. 30 Apr.,1903

Ulrich, Daniel. Div. Engr., Aqueduct Com., Manhattan. Jerome Park Reservoir, Kingsbridge, N. Y. 30 Apr.,1903

Van Buren, Robert. Prin. Asst. Engr., Dept. Water Supply, Gas and Elec., Brooklyn, Municipal Bldg., Brooklyn. 30 Apr.,1903

Van Buskirk, Clarence Randal. Transitman, Bureau Highways, Brooklyn, 108 Van Sicklen St., Brooklyn 30 Apr.,1903

Vanderbilt, Charles Horton. Computer, Topographical Bureau, The Bronx, 3 North Broadway, White Plains, N. Y. 30 Apr.,1903

Van Dusen, Gardner Lewis. Asst. Engr., Topographical Bureau, Queens, 3 Ridge Place, Mott Ave., New York. 30 Apr.,1903

Veitch, Andrew, Jr. Asst. Engr., Rapid Transit R. R. Com., Manhattan, 543 West 159th St., New York 30 Apr.,1903

Vogel, Henry William. Surveyor, Dept. Taxes and Assessments, Manhattan, 321 St. James St., Kingsbridge, N. Y. 30 Apr.,1903

von der Bosch, Oscar Waldemare. Asst. Engr., Bureau Highways, The Bronx, Third Ave. and 177th St., New York 30 Apr.,1903

Voorzanger, Louis. Topo. Draftsman, Topographical Bureau, Richmond, 230 Seventh Ave., Brooklyn, ... 30 Apr.,1903

Wagner, Bernard Matthew. Asst. Engr., Dept, Water Supply, Gas and Elec., Brooklyn, 257 Westminster Road, Flatbush, N. Y. 30 Apr.,1903

Wait, John Cassan. Counsellor at Law, 220 Broadway, New York 30 Apr.,1903

Waldreaon, Arthur George. Hort. Draftsman, Dept. Parks, Manhattan, Tottenville, N. Y. 30 Apr.,1903

Ward, Frederick. Topo. Draftsman, Topographical Bureau, Queens, 420 West 118th St., New York. 30 Apr.,1903

Watkins, Frederick W. Div. Engr., Aqueduct Com., Manhattan, 45 Rockledge Ave., White Plains, N. Y. 30 Apr.,1903

Wegman, Abraham Davidovitch. Topo. Draftsman, Topographical Bureau, The Bronx, 40 East 98th St., New York 30 Apr.,1903

Wegmann, Edward. Div. Engr., Aqueduct Com., Manhattan, Katonah, N. Y. 30 Apr.,1903

Weinberger, John Howard. Asst. Engr., Dept. Bridges, Manhattan, Park Row Bldg., Room 1217, New York... 30 Apr.,1903

Werbin, Israel Vernon. Asst. Engr., Rapid Transit R. R. Com., Manhattan, 52 East 107th St., New York 30 Apr.,1903

Wernberg, Edward Hargroves. Rodman, Rapid Transit R. R. Com., Manhattan, 4 Court Square, Brooklyn....	24 Feb., 1904
Wever, Benjamin Stuart. Asst. Eng., Dept. Docks and Ferries, Manhattan, Pier A, North River, New York...	30 Apr., 1903
Wheeler, Ralph Norman. Asst. Engr., Rapid Transit R. R. Com., Manhattan, 693 Rogers Ave., Brooklyn.........	30 Apr., 1903
Whipple, George Chandler. Biologist, Dept. Water Supply, Gas and Elec., Brooklyn, Eastern Parkway and Flatbush Ave., Brooklyn................................	30 Apr., 1903
White, Erastus Sherman. Asst. Engr., Offices Borough President, Brooklyn, 587 McDonough St., Brooklyn..	30 Apr., 1903
White, George, Jr. Draftsman, Dept. Water Supply, Gas and Elec., Manhattan, 149 West 142d St., New York..	30 Apr., 1903
White, Lazarus. Asst. Engr., Rapid Transit R. R. Com., Manhattan, 95 West 119th St., New York.............	30 Apr., 1903
Wilcock, Frederick. Asst. Engr., Rapid Transit R. R. Com., Manhattan, 862 50th St., Brooklyn.............	27 Jan., 1904
Wilkens, John Dietrich. Asst. Engr., Dept. Bridges, Manhattan, 152 East 56th St., New York..................	30 Apr., 1903
Williamson, Francis Stuart. Cons. Engr. to Borough President, Manhattan, 25 Broad St., New York.......	30 Apr., 1903
Wimmer, Robert Albert. Draftsman, Dept. Docks and Ferries, Manhattan, 1072 Park Ave., New York.......	30 Apr., 1903
Windowsky, Bernard. Topo. Draftsman, Topographical Bureau, The Bronx, Municipal Bldg., Third Ave. and 177th St., New York....................................	30 Apr., 1903
Winslow, George Edwin. Asst. Engr., Bureau Sewers, Brooklyn Municipal Bldg., Room 50, Brooklyn.......	30 Apr., 1903
Withington, Chandler. Prin. Asst. Engr., Dept. Finance, Manhattan, 280 Broadway, New York.................	30 Apr., 1903
Wood, George. Transitman, Topographical Bureau, Richmond, 189 Montague St., Room 205, Brooklyn........	30 Apr., 1903
Woythaler, Albert Berson. Cement Tester, Rapid Transit R. R. Com., Manhattan, 11 South St., New York......	30 Apr., 1903
Wynkoop, Hubert Schuurman. Elec. Engr., Dept. Water Supply, Gas and Elec., Brooklyn, Municipal Bldg., Room 33 A, Brooklyn..................................	30 Apr., 1903
Zartmann, William John. Supt. of Parks, Dept. Parks, Brooklyn, Ocean Ave. & Ave. K, Brooklyn...........	30 Apr., 1903

February 29, 1904.

DEPARTMENTAL LIST.

ACCOUNTS.

Manhattan.—H. A. Reid.

AQUEDUCT.

Manhattan.—R. Baldwin, Jr., C. E. Benedict, B. L. Blauvelt, A. S. Burgess, E. E. de Lancey, M. H. Lewis, C. C. Manning, R. A. McKim, J. O'Connor, F. B. Rogers, J. P. Schermerhorn, D. Ulrich, F. W. Watkins, E. Wegmann.

BRIDGES.

Manhattan.—J. W. Balet, W. R. Bascome, E. A. Byrne, N. Cummings, O. Erlandsen, G. R. Ferguson, E. A. Fintel, M. Gay, E. P. Herrmann, E. B. Jennings, E. D. Knap, J. A. Knighton, H. A. La Chicotte, K. L. Martin, A. McLean, L. S. Moisseiff, P. J. Murphy, O. F. Nichols, S. R. Probasco, H. D. Robinson, J. G. Theban, J. A. Tilly, J. H. Weinberger, J. D. Wilkens.

CIVIL SERVICE.

Manhattan.—P. S. Hildreth.

DOCKS.

Manhattan.—J. A. Bensel, W. J. Crowley, A. M. Goge, W. G. Johnson, A. J. Mimnaugh, M. Raymond, I. J. Stander, B. S. Wever, R. A. Wimmer.

EDUCATION.

Manhattan.—E. T. Bassett, H. B. Coffman, H. M. Devoe, E. L. Gunter, E. J. Lance, C. B. J. Snyder.

Brooklyn.—J. L. Brush, Jr.

The Bronx.—G. Krug.

Richmond.—S. R. Brick, Jr.

ESTIMATE.

Manhattan.—C. H. Haswell, N. P. Lewis, A. S. Tuttle.

FINANCE.

Manhattan.—A. W. Hankinson, A. J. Provost, Jr., W. E. Roach, W. H. Roberts, C. Withington.

FIRE.

Manhattan.—G. S. Pentz.

HIGHWAYS.

Manhattan.—M. L. Blum, J. B. Cunningham, D. Farrell, D. B. Goodsell, J. G. Horgan, J. Hunter, F. Kleeberg, W. Martin, E. Nagy, G. R. Olney, G. J. Steinacher.

Brooklyn.—W. H. Broadhurst, W. H. Connell, F. A. Drake, W. G. Foy, C. D. Pollock, J. Schmitt, G. W. Tillson, C. R. Van Buskirk.

The Bronx.—D. A. Curtin, W. J. Dunsing, E. T. Ebert, F. G. Fowler, W. E. Marrin, C. Stepath, S. C. Thompson, O. W. von der Bosch.

Queens.—T. J. Clarke, F. Skene.

Richmond.—G. F. Cornell, J. H. Riches.

LAW.

Manhattan.—J. McKenna, C. E. Raynor.

PARKS.

Manhattan.—N. H. Andrus, W. C. Bunting, E. C. Gregory, A. Herbert, F. A. Koch, D. McR. Livingston, S. Maulbeck, W. S. McDonald, E. A. Miller, J. F. Munckwitz, C. G. Reton, W. F. Richards, A. G. Waldreaon.

Brooklyn.—H. W. Dusenberry, R. M. Price, W. J. Zartmann.

The Bronx.—W. P. Hennessy, M. Schenck.

RAPID TRANSIT.

Manhattan.—L. C. Brink, F. W. Carpenter, A. Carr, G. H. Clark, E. W. Clarke, St. J. Clarke, R. Cranmer, A. Craven, S. Dahm, L. P. de Luze, W. J. Duncan, H. W. Durham, L. Durham, P. P. Farley, J. R. Ferris, G. S. Frost, C. Gaffney, J. R. Geoghan, J. W. Goodridge, C. N. Green, B. Hipkins, H. J. Howe, E. B. Johnson, J. Kearney, W. J. Keogh, B. Kipp, G. H. Lesley, A. Lodholz, J. H. Madden, J. R. Magrath, A. J. Mayell, E. B. McCready, J. J. McGuire, Jr., S. E. Meagher, W. W. Mills, C. Mulcahy, F. C. Noble, F. J. Perry, C. V. V. Powers, A. I. Raisman, G. S. Rice, R. Ridgway, W. A. Roffe, A. Schaeffer, T. B. Shertzer, J. O. Shipman, L. Sonn, W. F. Steinmetz, G. H. Sunkle, E. H. Thomes, A. Thompson, Jr., D. L. Turner, A. Vietch, Jr., I. V. Werbin, E. H. Wernberg, R. N. Wheeler, L. White, F. Wilcock, A. B. Woythaler.

SEWERS.

Manhattan.—M. J. Browne, O. Hufeland, H. Loomis.

Brooklyn.—H. R. Asserson, J. P. Clarke, W. T. Doyle, G. T. Hammond, J. F. Hammond, T. Hochlerner, I. H. Kirby, G. H. Knight, H I. Lurye, H. J. Lynch, W. S. Moore, J. C. Riedel, G. E. Winslow.

The Bronx.—E. F. Austen, W. W. Cohen, W. E. Dey, H. Jecks, E. L. Hartmann, W. F. Johnes.

Queens.—J. H. Johnson, J. P. McGraw, W. L. Pyne, A. Schreiner, H. Tait.

Richmond.—J. T. Fetherston, L. W. Freeman, V. H. Reichelt.

STREET CLEANING.

Manhattan.—M. Craven.

TAXES.

Manhattan.—H. Daube, F. W. Rubien, H. W. Vogel.

TENEMENT HOUSE.

Manhattan.—J. B. Duncklee.

TOPOGRAPHICAL.

Manhattan.—E. Q. Morton.

Brooklyn.—G. J. Bischof, H. C. Head, E. Riordan, G. J. Schweitzer, J. B. Stein.

The Bronx.—C. P. Bonnett, W. S. Dalrymple, F. Greiffenberg, P. L. Haas, J. T. Hefele, W. A. Herckenrath, E. H. Holden, J. Owen, E. J. Plasman, C. E. Risse, C. H. Vanderbilt, A. D. Wegman, B. Windowsky.

Queens.—E. Ankener, R. R. Crowell, W. G. Eliot, H. K. Endemann, F. L. Greiffenberg, R. T. Johnson, A. La Forge, C. J. Mueller, A. Nagy, C. U. Powell, W. A. Rowan, G. L. Van Dusen, F. Ward.

Richmond.—U. S. Lutz, W. MacDonald, E. Stout, G. W. Tuttle, L. Voorzanger, G. Wood.

WATER SUPPLY.

Manhattan.—E. Agramonte, Jr., F. K. Betts, R. L. Blake. C. H. Bull, L. F. Cox, T. C. Culyer, J. E. Deignan, A. S. Farmer, N. S. Hill, Jr., W. D. Lintz, E. J. Maurer, T. Melius, G. E. Rodman, H. A. Ruge, W. S. Ryan, G. F. Sever, L. C. L. Smith, C. H. Steers, G. A. Taber, A. R. Taylor, G. White, Jr.

Brooklyn.—A. E. Allen, R. Ankener, W. W. Brush, W. S. L. Cleverdon, I. M. de Verona, J. F. Durney, J. D. Griffiths, J. Hayman, D. D. Jackson, W. F. Laase, C. Lobo, W. B. Osterhout, G. S. Skilton, C. P. Sullivan, K. Torrance, R. Van Buren, B. M. Wagner, G. C. Whipple, H. S. Wynkoop.

NOT CLASSIFIED.

Manhattan.—J. C. Bayles, F. S. Williamson.

Brooklyn.—E. S. White.

The Bronx.—J. A. Briggs, C. Gartensteig.

Richmond.—M. Bernhardt, Jr., J. F. Creeden, A. F. Grünenthal, W. R. Hillyer, S. R. Hurlbut, S. Muenz, T. S. Oxholm, L. L. Tribus.

Not in City Service.—T. F. Adriance, W. H. Burr, G. W. Culgin, R. Hering, W. R. Hill, C. Mazeau, J. S. Reeve, D. C. Serber, J. C. Wait.

February 29, 1904.

SUMMARY OF MEMBERSHIP.

Commissioners of Accounts	1
Aqueduct Commissioners	14
Department of Bridges	24
Civil Service Commission	1
Department of Docks and Ferries	9
Department of Education	9
Board of Estimate and Apportionment	3
Department of Finance	5
Fire Department	1
Bureaus of Highways	31
Law Department	2
Department of Parks	18
Board of Rapid Transit Railroad Commissioners	59
Bureaus of Sewers	30
Department of Street Cleaning	1
Department of Taxes and Assessments	3
Tenement House Department	1
Topographical Bureaus	38
Department of Water Supply, Gas and Electricity	40
Not Classified	13
Not in City Service	9
Total Membership, February 29, 1904	312

NECROLOGY.

Members who have died during the year.

1903.

Theodore W. C. Happel	Charter Member, 30 Apr., 1903
Charles Cyril Martin	Charter Member, 30 Apr., 1903

February 29, 1904.

ANNUAL REPORT.

To the Society:

Your Board of Directors has the honor to submit this its First Annual Report. The first meeting of the Board was held on April 30, 1903 and it immediately commenced to pass upon the names which had been enrolled at the preliminary meetings of the Society for organization, in compliance with the resolution of the Society of April 3, 1903. Each name vouched for by two of the Directors was accepted for membership. In this way nearly three hundred names were passed. Those who were not well known to two Directors were asked to send in their records on the application for membership blanks and these were investigated by the Membership Committee as fast as they were received and were voted upon by the Board after the Committee reported in each case. Many members failed to send in their records till late in the year so that the Board, having no proper information regarding them, was unable to finish this work until the December meeting. It was found too that many names passed at the first meeting had been improperly enrolled by other persons than the owners of the names without authority and some men who enrolled themselves afterward changed their minds and decided not to become members, others allowed their names to remain on the roll but failed to pay their dues or to attend the meetings. It is only now therefore, at the annual meeting, that the Board is able to state the real membership as given in the reports of the Secretary and Membership Committee. All members originally enrolled who were passed by the Board however late, are recorded as charter members.

The Board has been careful to keep the expenses of the Society as low as is consistent with the interests of its members. It has been fortunate that the members have been so ambitious for success that they have been willing to contribute a full year's dues for the first eight months of the existence of the Society. The receipts for a year and expenditures for only eight months accounts for the good balance on hand December 31, 1903, as shown by the reports of the Secretary, Treasurer and Finance Committee. It must be borne in mind, however, that no charge has been made during the first year for the cost of issuing the annual publications nor for the furnishing of permanent quarters.

It is to the credit of the Publication and Library Committee that it succeeded in providing a paper for every meeting of the first year. Unfortunately the illness of Professor Burr prevented him from reading his paper at the December meeting but the subject was nevertheless very interestingly developed on special lines by Messrs. George S. Rice, Arthur S. Tuttle, Daniel D. Jackson, William W. Brush and others. The Board approved of the recommendations of the Committee contained in the last paragraph of its report.

The House Committee has worked hard to find satisfactory quarters in addition to its other duties of providing the monthly meeting place, the refreshments and the annual dinner. By its untiring efforts it has accumulated valuable information for the new Committee in its selection of quarters. The Board wishes to urge the new Committee to renewed efforts to obtain permanent quarters as soon as possible in order that the important work of gathering a library of books, reports, specifications, plans and maps, which will be of great benefit, may be begun and also to enlarge the social attractions of our Society. It is expected also that these advantages will attract many new members.

The Committee on Inspections has been happy in its choice of works which have been visited, and the trips have been well attended and very enjoyable and instructive. Thanks are especially due to the engineers and contractors connected with these works for their many courtesies.

No report has been received from the Committee on Prizes, the time for its report to be presented having been postponed until the papers are all revised by their authors and put in such form that the Committee's judgment may not err.

The Board believes that the conditions at the end of the first year are distinctly favorable and that the success of the Society is assured. It is with great pleasure that the Board acknowledges the cordial co-operation of the Society in all of its endeavors.

The annual reports of the Committees are appended.

BY THE BOARD OF DIRECTORS,
(Signed) WISNER MARTIN,
Secretary.

JANUARY 27, 1904.

SECRETARY'S REPORT.

The Board of Directors:

Sirs,—In accordance with the By-Laws I beg to submit the following Annual Report:

A statement of receipts and disbursements is appended.

The only tangible property of the Society is an oak filing cabinet which cost thirty-five dollars. It was made to order and was arranged for filing the applications for membership, the membership index cards, letters and bills.

Referring to our membership during the past year:

At the preliminary meetings of February 25, 1903, and April 3, 1903, there were enrolled		414
Died	2	
Resigned	2	
Withdrew from membership	21	
Not passed by the Board	48	
Dropped for non-payment of dues	35	
	——	108
		306
New members elected		5
Present membership		311

Very respectfully,

(Signed) WISNER MARTIN,
Secretary.

January 27, 1904.

ANNUAL STATEMENT OF RECEIPTS AND DISBURSEMENTS, FROM APRIL 22, 1903, TO DECEMBER 31, 1903.

RECEIPTS.		DISBURSEMENTS.	
Balance on hand April 22.	$1 85	Publication..........	$85.00
Dues..................	2,586.00	House.	210.00
Interest...............	13.10	Refreshments.........	333.10
*Miscellaneous.........	5.10	Salaries...............	290.17
		Printing............	211.60
		Postage.............	101.49
		Office Expenses.......	58.75
		*Miscellaneous.......	28.83
			$1,318.94
		Balance with Treasurer.	1,249.64
		Balance with Secretary.	37.47
	$2,606.05		$2,606.05

* Includes Treasurer's bond, dues refunded, bank charges, etc.

Certified correct,
(Signed) WISNER MARTIN,
Secretary.

JANUARY 27, 1904.

TREASURER'S REPORT.

THE BOARD OF DIRECTORS:

SIRS,—In compliance with the provisions of Article VIII of the By-Laws, I have the honor to present the following Annual Report covering the financial transactions of the Society from April 22, 1903, the date of election of the first permanent officers, to January 1, 1904.

RECEIPTS:

Balance on hand on April 22, 1903, from the funds raised for meeting the preliminary expenses of organizing........	$1.85
Received from the Secretary in 18 installments between April 22, 1903 and Jan. 1, 1904, collections for 1903, aggregating..	2,591.00
Received for collection charges on check....................	.10
Interest on balance to Jan. 1, 1904........................	13.10
	$2,606.05

DISBURSEMENTS:

Expended on account of bills countersigned by the Secretary and by the Chairman of the Finance Committee and approved and ordered paid by the Board of Directors, aggregating 61 in number..............................	$1,356.41
Cash on hand January 1, 1904.....	1,249.64

The funds of the Society are deposited with the Washington Trust Co. where they are credited with interest at the rate of two and one-half per cent. per annum.

Respectfully submitted,
(Signed) ARTHUR S. TUTTLE,
Treasurer.

Examined and found correct,
Finance Committee,
(Signed) O. F. NICHOLS,
Chairman.

JANUARY 27, 1904.

REPORT OF FINANCE COMMITTEE.

The Board of Directors:

Sirs,—Having examined the books of the Treasurer to December 31, 1903 and compared the checks issued in payment of vouchers with the bank account, we find the Annual Report of the Treasurer, submitted herewith, to be correct and the balance on hand in the Washington Trust Company to be as stated in the report, to wit: $1,249.64 on January 1, 1904.

We have examined the statement of receipts and disbursements from April 22 to December 31, 1903 as made to us by the Secretary and find this statement to be correct. This statement shows a cash balance in the hands of the Secretary on January 1, 1904, of 37.47, so that the funds in the hands of the Treasurer and Secretary on January 1, 1904, were $1,287.11.

Respectfully submitted,
Finance Committee,
(Signed) O. F. NICHOLS,
Chairman.

January 27, 1904.

REPORT OF MEMBERSHIP COMMITTEE.

The Board of Directors:

Sirs,—Our Annual Report is as follows:

Number of members originally enrolled	414	
Number of members elected by the Board	5	
		419
Died	2	
Withdrawn or dropped from membership	106	
		108
Membership on January 27th, 1904		311

Respectfully submitted,
Membership Committee,
(Signed) S. C. THOMPSON,
Chairman.

January 27, 1904.

REPORT OF PUBLICATION AND LIBRARY COMMITTEE.

The Board of Directors:

Sirs,—The Publication and Library Committee presents the following report for the year 1903:

There have been five papers presented to the Society as follows:

The Building of Parks and Parkways in New York City	Nelson P. Lewis.
Roman Aqueducts	Edward Wegmann.
Rapid Transit in New York City	George S. Rice.
Some Street Traffic Problems	Wisner Martin.
Some Problems of Asphalt Pavement Maintenance in Manhattan	James C. Bayles.

At the last meeting of the Society it was arranged that Professor William H. Burr should talk to the Society on the subject of Additional Water Supply for New York City but at the last moment Professor Burr's voice failed him and the matter was informally discussed by several members pending the presentation of the paper at a later date.

As there is a nucleus now for the publication of the papers, the Committee recommends that the Board of Directors authorize the selection of an Editor and a Business Manager who shall properly edit and have printed the papers already presented and that the cost of editing and printing be paid for by means of advertising in the publication.

Respectfully submitted,
Publication and Library Committee,
(Signed) GEORGE S. RICE,
Chairman.

January 27, 1904.

REPORT OF HOUSE COMMITTEE.

The Board of Directors:

Sirs,—The House Committee presents to the Board of Directors, in conformity with the requirements of Article XI of the By-Laws, a brief report of the work done by it during the year 1903.

Permanent society rooms not having been established at the time of organization, it became necessary for this committee to provide temporary quarters at which the monthly meetings could be held. Arrangements were made with the Mechanical Engineers, Carnegie Hall, and the Chemists Club. The meetings were fairly patronized as to numbers of members present and it is found that the average attendance was 130.

At these meetings papers were read and general discussion followed, after which a collation was served.

The committee has had under consideration for some time the establishment of permanent quarters for the Society in a location central and easy of access when considering the various boroughs. Suitable rooms in office buildings seemed too expensive and could not be considered. The Carnegie Hall proposition, that of obtaining two rooms and the use of the music hall, also received due consideration and was suggested to the Board but the available funds in the treasury and the membership of the Society did not warrant the necessary outlay. The committee further investigated the renting or purchasing of a private house in a central location but was again confronted with the expense for rent, gas, fuel, etc., which would exceed the money which could be set aside to cover these expenses. The solution of the problem, the establishment of permanent quarters, seems to us a difficult one but we still adhere to our idea that the renting of a private house now that the Society is incorporated and the remodeling of it, even at a rental and general expense greater than the Society can afford at this time, is the only proper solution of the problem. The deficit incurred, should there be any, might be taxed against the members in general or covered by voluntary subscriptions.

Under the present conditions the Municipal Engineers are without a home and under these conditions the increase in membership and the drawing to us of younger members can scarcely be looked for and it is earnestly suggested that this matter of permanent quarters be carefully considered by the incoming House Committee, our successor, and that the investigations for obtaining a private house be further pursued.

In concluding, we beg to state that our annual banquet was held at the Park Avenue Hotel on January fourteenth, that covers were laid for 110 members and that the income from the sale of tickets practically covered the expenses.

Thanking you for your kind support and for that which the members of the Society in general rendered, we have the honor to remain.

Yours respectfully,

The House Committee,

(Signed) EDWARD A. MILLER,

Chairman.

JANUARY 27, 1904.

REPORT OF COMMITTEE ON INSPECTIONS.

THE BOARD OF DIRECTORS :

SIRS,—The Committee on Inspections hereby submits its report of the work done, as provided by the Constitution.

It was decided that the first trip should be made to inspect the caissons of the Manhattan tower foundation of the Manhattan Bridge. This trip was made on Saturday, October tenth, the party meeting at the office of the engineer in charge at about two-thirty o'clock in the afternoon. About fifty men were present and an inspection was made of the contractor's plant at this point. An opportunity was given, for such members as desired, to go down into the caissons which at that time had reached a depth of about 44 feet below mean high water. About twelve men availed themselves of this privilege, the remainder being satisfied with an inspection of the surface work. The party was shown over the work by Mr. Henry A. La Chicotte, Principal Assistant Engineer, Department of Bridges, in charge of the work and by his assistant, Mr. John A. Knighton, members of this Society.

The Committee decided that the next trip of the Society should be made to inspect the New Croton Dam and various other works in the Croton Valley. This trip was planned to take place on Saturday, November fourteenth, but had to be postponed on account of the weather until Saturday, November twenty-first. Eighty persons, members and guests, took part in this trip, the party going by way of the New York Central and Hudson River Railroad to Croton Landing where they took omnibuses for the New Croton Dam arriving there about eleven o'clock. The party was very cordially received by Mr. John Byron Goldsborough, superintendent for the contractors, Messrs. Coleman, Breuchaud & Coleman. The party then made a thorough inspection of the dam under the guidance of Mr. Charles S. Gowen, Division Engineer of the Aqueduct Commissioners, and his assistants. The party then took omnibuses up the Croton Valley to the Old Croton Dam where dinner was served at a nearby hotel. After dinner, the party again took the omnibuses, a small number going up the Croton Valley to Katonah, and the greater number going to the Croton Lake station of the New York and Northern Railroad and returning to New York, thereby leaving out the latter part of the trip.

The Committee decided that the next trip should be made to the Williamsburg Bridge and the member of the committee in charge of the work on this bridge was requested to arrange for the trip. For some reason unknown to the Chairman no arrangements could be made. On account of the cold weather immediately ensuing the committee did not think it advisable to arrange for any other trip during the month of December. The Committee also thought it inadvisable to arrange for a trip during the month of January on account of the fact that the annual meeting of the Society occurs during that month and also because of the fact that the American Society of Civil Engineers and several other societies have their annual meetings during the month of January.

The work of the Committee therefore may be assumed as having been finished with the trip to the Croton Dam and it, of course, has not taken any steps toward arranging for trips after the annual meeting as it did not feel at liberty to hamper its successor in any way.

Respectfully,
Committee on Inspections,
(Signed) ALBERT CARR,
Chairman.

January 27, 1904.

PAPERS AND AUTHORS.

THE BUILDING OF PARKS AND PARKWAYS IN NEW YORK CITY.

By Nelson P. Lewis, A. B., C. E., Chief Engineer for the Board of Estimate and Apportionment.

ROMAN AQUEDUCTS.

By Edward Wegmann, C. E., Division Engineer for the Aqueduct Commissioners.

RAPID TRANSIT IN NEW YORK CITY.

By George S. Rice, S. B., Deputy Chief Engineer for the Board of Rapid Transit Railroad Commissioners.

SOME STREET TRAFFIC PROBLEMS.

By Wisner Martin, S. B., Principal Assistant Engineer of the Bureau of Highways for Manhattan.

SOME PROBLEMS OF ASPHALT PAVEMENT MAINTENANCE IN MANHATTAN.

By James C. Bayles, M. E., Ph. D., Consulting Engineer to the Borough President of Manhattan.

AWARD OF PRIZE.

The Society Prize has not yet been awarded. See page 47.

WORKS INSPECTED.

The Foundation of the Manhattan Tower of the Manhattan Bridge, at the foot of Pike Slip, East River.

New Croton Dam, near Quaker Bridge, Cortlandt Township, Westchester County, and **Old Croton Dam,** near Yorktown Heights, Yorktown Township, Westchester County.

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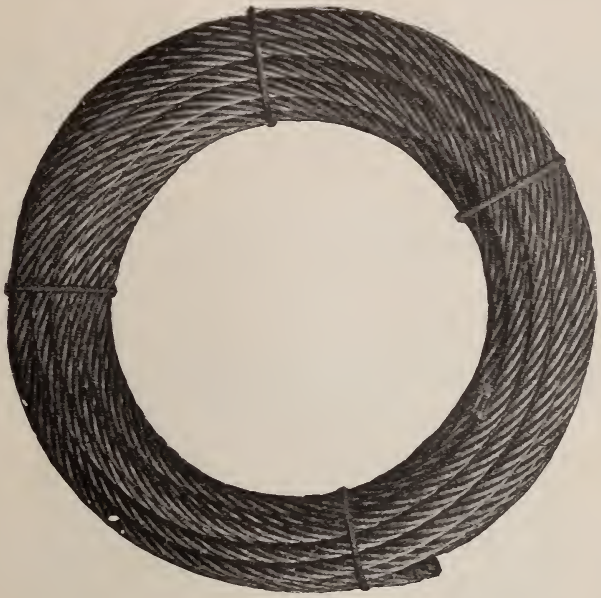

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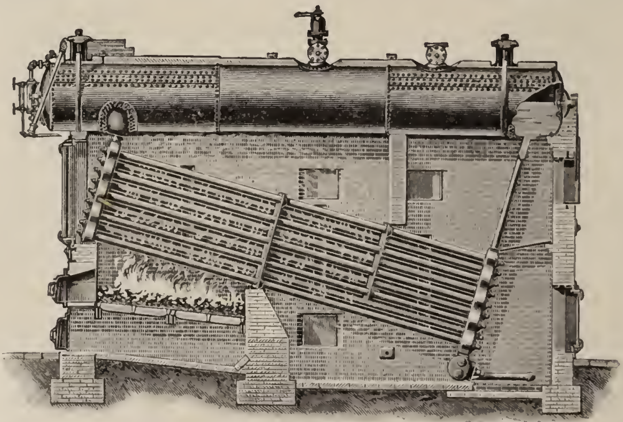

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Department of Bridges	2,050
Department of Correction	675
Department of Docks and Ferries (including boilers for Five Staten Island Ferry Boats)	6,000
Miscellaneous	1,300
	52,270

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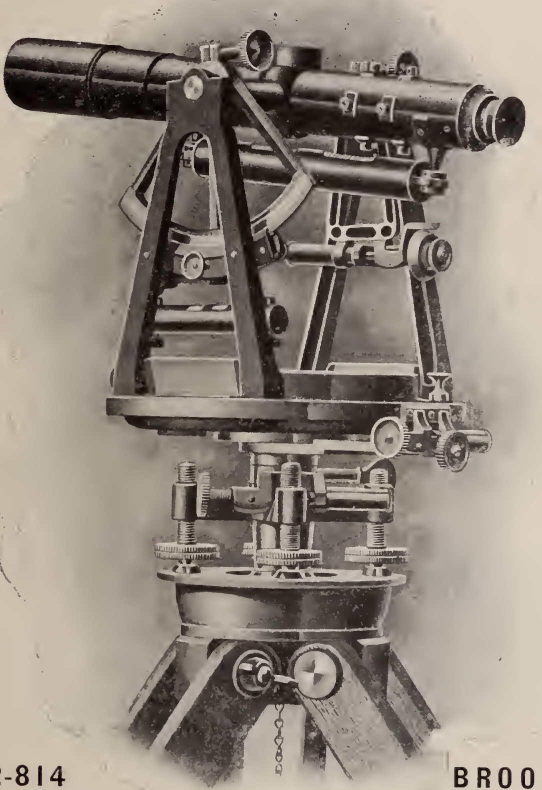

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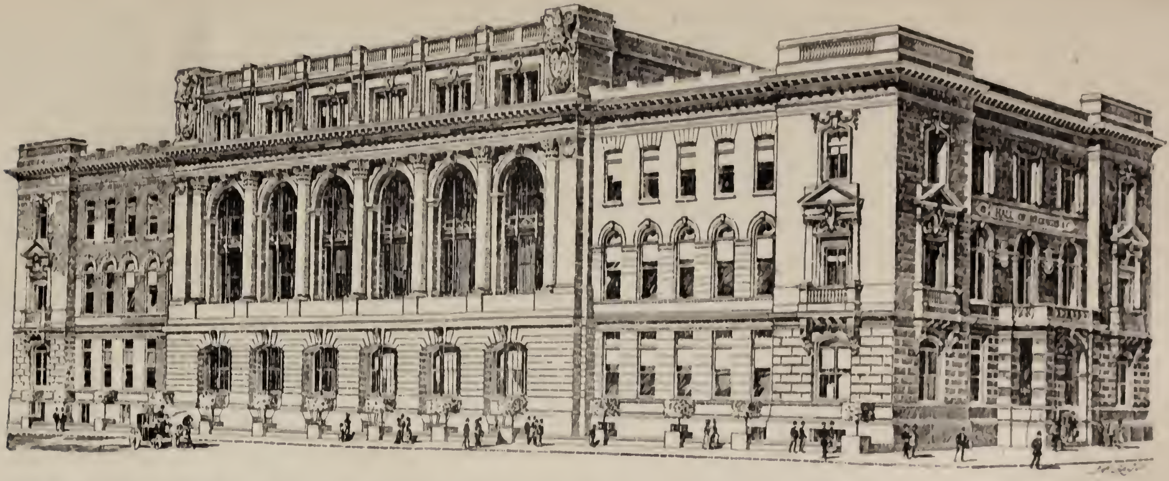

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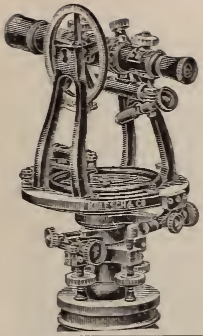

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Reinforced Concrete

BY

CHARLES F. MARSH

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With many Tables, Diagrams and Engravings

CONTENTS:

General View of the Subject. Systems Employed. Materials. Practical Construction. Experimental Research and Data Deduced Therefrom. Calculations. Some Structures which have been Erected in Reinforced Concrete. Appendix.

INTRODUCTION

In the following pages the author has endeavoured to place before engineers, architects, and others, a complete treatment of the subject of reinforced concrete, in so far as is possible at the present day.

All the subject matter has been so arranged as to facilitate reference as much as possible, and the several systems used up to the present have been placed in alphabetical order, so that any particular one may be readily found when desired.

It is believed that the part relating to the calculations, covers all forms of construction in as concise and clear a manner as possible. The formulæ for slabs and beams, although giving somewhat smaller dimensions than those recommended by M. Christophe in *Le Beton Armé* (a standard French work on the subject), are still well on the side of safety, and it is hoped that the tables and diagrams may be of use in saving the labour necessary in making the requisite calculations. The subject of arches has been dealt with in as condensed a form as possible, compatible with a clear demonstration of the methods adopted for locating the pressure curve. The graphical method for finding the stresses to be resisted in domed coverings, is believed to be entirely new and greatly simplifies the treatment of these structures.

It has been considered advisable to illustrate the book very fully, in order that all the subject matter, where possible, may be rendered clearer, and that a true idea may be formed of the remarkable adaptability of reinforced concrete for constructural purposes.

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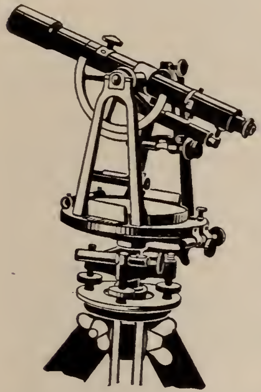

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